SCIENTIFIC AMERICAN

No. SUPPLEMENT 173

Scientific American Supplement, Vol. VII., No. 173. | NEW YORK, APRIL 26, 1879. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

THE NEW OBSERVATORY ON THE PIC DU MIDI, OF THE PYRENEES.

For several years past General Nasouty, of the Société Ramond, has been carrying on a system of meteorological observations at Station Plantade, on the Pic du Midi de Pau, one of the higher peaks of the Pyrenees, in the southern part of France. This observatory, exceedingly humble in its appointments, has been sustained by the generous meteorologist, Nasouty, chiefly at his own private expense, and for pure love of science, and has been of incalculable benefit to the population of the neighboring departments. Not long since, General Nasouty resolved to replace the humble buildings which have sheltered him so long by a more elaborate structure and at a higher elevation—in fact, on the very summit of the mountain peak. The necessary funds for accomplishing this design have been furnished by several generous friends of science. The commission who have charge of the construction of the new observatory have been greatly aided by the advice of the celebrated architect, Viollet le Duc. The accompanying figure (Fig. 1) gives a view of the new structure as it will appear when finished. At present it is only partially constructed. At the right, perched on a plateau, is seen the shelter for the meteorological instruments. In the center is the dwelling house, the plan of which is seen in Fig. 2. At the left is the lightning rod, designed to protect the dwelling from the lightning, which very frequently strikes the summit of the peak. This rod, with its cable 1,600 feet long stretching down and dipping into Lake Oncet, cost $560. The labor of clearing away the hollow in which the structure is built necessitated an expense of $500. The half of the observatory which is already constructed cost $4,400. Referring to Fig. 2, the left hand figure represents the plan of the first story: 1 is the storeroom; 2, parlor; 3, stairway; 4, dining room; 5, workroom; 6, guest chamber; 7, telegraph; 8 and 9, bedrooms. The ground floor will be a storing place for provisions.

The example set by General Nasouty has already borne its fruit; General Farre has just inaugurated an observatory at Fort Infernet, and there is some talk of establishing one on Mount Ventoux. The latter will be a unique situation, and will render immense service to science.

Fig. 1.—VIEW OF NEW OBSERVATORY ON THE PIC DU MIDI.

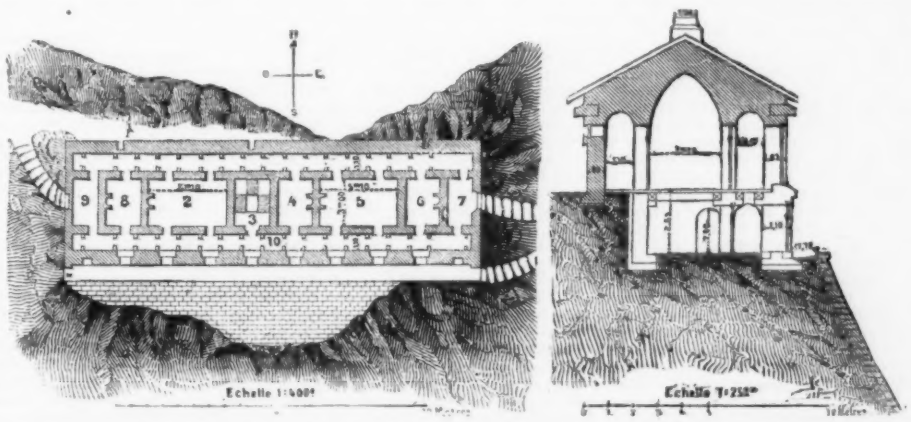


Fig. 2.—FIRST-FLOOR PLAN AND SECTION OF NEW OBSERVATORY.

CONNECTION BETWEEN THE DAILY FLUCTUATIONS OF THE BAROMETER AND OF THE MAGNETIC NEEDLE.*

By Prof. John D. Parker.

At a recent meeting of the Academy of Science, Prof. J. M. Greenwood asked the following question: "Is there any connection between the daily maxima and minima of the barometer, and the diurnal fluctuations of the magnetic needle?" Let us consider this question in the light of general principles.

First, what causes the daily maxima and minima of the barometer? It is a familiar truth that a column of mercury, at the level of the sea, about thirty inches in height, weighs the same as a column of air of the same base extending to the top of the atmosphere. In an atmosphere *in equilibrio* in temperature, all its columns from base to extreme surface would be of the same height and weight. If a column of air be heated it will expand and flow over the neighboring columns, or lose its weight; but if a column be cooled it will contract, and the neighboring columns will flow into it and increase its weight. If the barometer falls in a country it is because the temperature of that country is higher than that of neighboring countries, whether heated directly, or those regions have cooled. If the barometer should rise in a country it proves that this country has become colder than those regions that surround it. As a region becomes heated, we should expect that the barometer would fall there and *vice versa*. Rain, according to these principles, is only an effect produced by the conditions of the atmosphere which the barometer detects. When a region of the earth is heated, the weight of the atmosphere becomes less, and the vapors gradually settle toward the earth, and are precipitated in rain.

In accordance with these principles a maximum of the barometer should occur at midsummer, while two opposite daily crises should occur at the hours of greatest heat and greatest cold. Observation proves a general correspondence with these laws with some anomalies. The atmosphere proper contains a small amount of vapor, which may be termed the vaporous atmosphere. The increase of the solar heat due to the season, or hour of the day, augments the amount and weight of this vaporous atmosphere. Its relation to the barometer is, therefore, inverse of that of the atmosphere proper, or the permanently elastic fluid. Out of this contradiction all the anomalies spring. If we separate these two atmospheres, and note simply the effects of the permanently elastic envelope, we find the heights of the barometer are inverse the heights of the thermometer. Combine these two atmospheres, and we have three barometric curves, only two of which need now be considered. From the maximum height of midwinter the pressure diminishes until the vernal equinox, because the dry air expands, diminishing its weight, without a corresponding increase in the amount of vapor. From the vernal equinox the pressure increases during the summer months, because the rapidly increasing vapor more than compensates for the diminution of the weight of the dry air. From the autumnal equinox the total pressure diminishes, the aqueous atmosphere precipitates rapidly, while the weight of the dry air augments slowly, after which the barometric curve ascends gradually until the barometer attains its winter or absolute maximum.

We are prepared now, in the light of these general principles, to understand the daily maxima and minima of the barometer, or the diurnal curve. Take out the effect of the vaporous atmosphere, and we reduce the barometer to a single diurnal curve—a maximum at the hour of greatest cold, and minimum at the hour of greatest heat. Combine the two atmospheres, and we have two maxima and two minima, in general as follows:

Minimum of morning,	3 hours and 45 minutes A.M.
Maximum "	9 hours and 37 minutes A.M.
Minimum of evening,	4 hours and 5 minutes P.M.
Maximum "	10 hours and 11 minutes P.M.

During winter these hours are nearer midday by a difference, sometimes of nearly two hours. The diurnal curve, of course, is greatest at the equator, where we find the most vapor, and diminishes toward the poles. We find, therefore, that the daily maxima and minima of the barometer are due to the solar heat operating upon the two atmospheres that constitute the total envelope of the earth.

Secondly, let us consider if the daily fluctuations of the magnetic needle can be traced to the same general cause. We can see this part of our subject also better in the light of general principles. A steel bar magnetized, and freely suspended from its center of gravity, does not coincide with the geographical meridian, but deviates by an angle termed magnetic declination. The line along which the needle lies is called the magnetic meridian. The needle has also a tendency to dip as we approach the magnetic poles. The illustrious Humboldt induced the Russian and British governments to establish magnetic observatories in various places, so that maps (like these charts) of the magnetic meridians have been constructed.

Now, if you take a wire and pass a current of electricity through it, you find the magnetic needle will, when brought near it, take a position at right angles to the wire. It has been found that the solar heat induces currents of electricity in the earth which pass around it from east to west. The immense quantity of vapor abstracted from the ocean in the equatorial regions also conveys electricity with it toward both poles, which is discharged more copiously at certain seasons, causing the Aurora Borealis and the Aurora Australis. These currents, in returning toward the equator, probably combine with the currents of electricity passing around the earth from east to west, and cause the needle to deviate, destroying the coincidence of the geographical and magnetic meridians.

We are now better prepared to understand the daily fluctuations of the magnetic needle. The pole of the needle least distant from the sun makes a double diurnal excursion. It is at its western maximum from four to five hours before the sun crosses the meridian of the place, then moves eastward, reaching its eastern limit one or two hours after the sun passes the meridian, and repeats this variation, within less extended limits, as the sun passes the inferior meridian.

Thus we see that the daily maxima and minima of the barometer occur at nearly the same hours as the diurnal fluctuations of the needle. The daily excursions of the needle are doubtless due to the variations induced in the electrical currents by the increase of the solar heat, which, also operating through the two atmospheres composing the total envelope of the earth, causes diurnal fluctuations of the barometer. Both fluctuations are probably due to the same cause, the solar heat, which, however, operates in different ways and through different media. This is sometimes termed the thermo-electrical theory, and may be accepted until a better one is discovered.

Prof. Greenwood asked the author of the paper if he thought heat produced electricity. Prof. Parker replied that heat does not produce electricity as an acorn produces an oak; but a disturbance of the thermal conditions produces a disturbance of the electrical conditions. As illustrations of this principle, a lamp will cause a current of electricity to flow along a wire, and a very hot day is sometimes followed by a thunder-shower, or more often by what is known as heat-lightning.—*Kansas City Review.*

* Abstract of a paper presented at the February meeting of the Kansas City Academy of Science.

Count Wilczek and Lieut. Weyprecht intend to visit the coast of Nova Zembla in the course of the present year, in order to make a series of exact magnetic, electric, hydrographical, and meteorological observations.

FOGS AND THEIR CAUSES.

By R. A. Proctor, B.A.

On Monday, February 17, a very remarkable cloud passed over the western and southern parts of London. I do not remember to have ever before noticed a darkness so intense in the daytime. Until about eleven the sky had been covered with the peculiar yellow-colored cloud which Londoners are accustomed to recognize during the season of fogs. This cloud gradually grew darker, until it became impossible to read or write without using artificial illumination. Being then led to notice the sky, I observed that toward the north (my residence being south of the Thames) the sky was very much darker, and that the increasing darkness was due to the gradual southerly motion of the overhanging pall of clouds. From that time the darkness increased rapidly, until shortly before noon it seemed as dark as on a moonless night, though doubtless part of the effect was due to contrast. Yet all the time there was very little fog. The air was hazy, but lights at a distance of two or three hundred yards could be well seen.

Many were thus led to believe that the phenomenon was not in any way connected with the ordinary fog of the metropolis, the so-called "London particular." In reality, however, there is no reason to doubt that the darkness was due to a fog-stratum a little above the level of the ground. The phenomena presented during a London fog are quite sufficient to explain even so remarkable a darkness as prevailed for about half an hour on the 17th inst. Those phenomena are commonly misunderstood. Very few are aware how shallow, relatively, is the layer of fog which, while it continues to inwrap the city, makes even the crossing of a street dangerous, and suddenly puts an end to nine-tenths of the business movements of the metropolis. Indeed, a little consideration will show that if a London fog were deep the whole city must be plunged in darkness rivaling or surpassing that of midnight. In a true London fog the light of a street lamp is lost at a distance of four or five yards, and even the electric light would not penetrate more than twenty yards or so. The light of the sun, which is, of course, pouring all the time on the outside of the fog layer, is in like manner absorbed by the dense fog; so that if the layer were forty or fifty yards in thickness, no light whatever could reach the streets.

But even in the densest London fog absolute darkness does not prevail. I do not think that any one can remember, even in the heart of the city, the occurrence of as deep a darkness during fog as prevailed on the 17th, when in the streets there was little fog. So that it is certain the fog layer cannot be at any time very deep—it is generally, if not always, very shallow. I remember a case in which the shallowness of a really dense and heavy fog was well shown. During a fog which prevailed one Sunday morning in the south of London the darkness was for a while remarkable. Where railway bridges (of the usual breadth for a double service) crossed the road, it appeared as one approach, as though one were entering a perfectly black passage. Under such a bridge, and midway under the bridge, no light could be seen except where, toward either end of the covered way, a rectangle could be distinguished showing not quite black against the black outline of the bridge, the ground, and the uprights supporting the bridge. Yet from the upper windows of a rather high house the clear sky could be seen. After a while the fog layer became shallower; and before long one could see from one side of a street the first floor windows of the opposite houses, not only quite clearly, but actually in sunlight, while the windows of the ground floor could scarcely be distinguished through the fog.

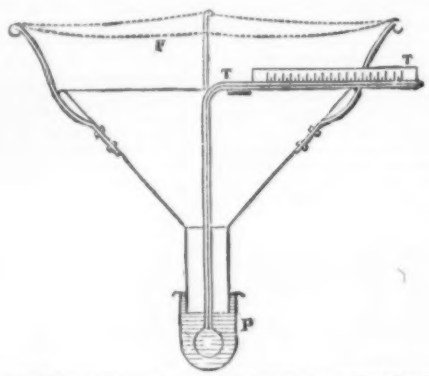
Again, at the Greenwich Observatory, it is noticed that during the thickest London fogs the air is clear a short distance above the tops of the houses, while often the roofs of the higher houses can be seen with perfect distinctness at the very time when the business of the streets is impeded by dense fog, and the gas is lit in streets, shops, and offices.

There can be no doubt that the remarkable darkness on the 17th was due simply to a fog layer which lay above the houses, instead of enveloping them as usual. An ordinary fog, reaching from the ground to a certain definite height, may be regarded as deprived of a part of its natural thickness where the ground limits it. If we imagine such a layer gradually rising, either through some motion in the air, or (which, no doubt, is the more usual, if not the only possible, cause) through the gradual extension upward of those conditions of temperature, etc., on which the formation of the London fog depends, we can understand that the fog would grow in height without leaving the ground, until a certain maximum of thickness had been obtained. The further progress of the change would cause the fog to grow less dense, or to disappear at the ground level, while the fog layer would retain its thickness. In such a case there would be clear, or only hazy streets, and an impenetrable layer of fog overhead. The darkness would be much greater than in an ordinary London fog, because the thickness of the fog layer would be greater; and the darkness would seem all the more intense because of the comparative absence of fog in the streets. Such, no doubt, was the fog layer which overspread certain parts of London on the 17th.

It should be noticed that, although in speaking of an ordinary fog we may say that when such a fog has lifted from the ground it is a cloud, his would hardly be true in the case of a London fog, unless the word cloud is taken in a wider sense than is usual. For a London fog owes its peculiar density in great part to the presence of small particles of soot, the familiar "blacks" of London and other smoky towns. Ordinarily these get dispersed by the movements of the air. But in the conditions favoring the formation of fogs, they help, in the first place—by radiating their heat away—to form the fog, and in the second place, becoming heavy with the moisture that condenses upon them, they are not carried upward by the warmer currents from the chimneys, etc., whence they are poured. So that we have a layer of fog and wet smoke, so to speak, the fog thicker, even as fog, than that which forms elsewhere, and the smoke rendered denser by concentration.—*Newcastle Chronicle.*

STUDY OF HAILSTORMS AND THEIR ACCOMPANYING PHENOMENA.

The formation of hail, and the various causes which may contribute to this phenomenon, are very interesting, and, as yet, obscure questions of meteorology; and all the theories that have been proposed to account for it still leave much to be desired. Owing to this fact it will be well to collect together as many and as exact data as we can in regard to the principal phenomena, so that the problem may hereafter be more easily solved. M. Colladon, of France, who has given this subject much attention, and some of whose papers have already been brought before the French Academy, proposes the following series of questions, to be answered by observers: (1) Dates as exact as possible, and returns comparable with the hour of the commencement and end of the hailstorm, at various stations, and the area embraced by the storm. (2) Mean and maximum dimensions of the hailstones, their form, the mean or maximum number of layers they exhibit, and whether these layers increase in thickness from the central nucleus towards the circumference. (3) Apparent form and elevation of the hail clouds, and whether they exhibit the appearance of a great and continuous gyratory movement, or merely movements of attraction and repulsion; the number of flashes of lightning, and whether or not they are accompanied by thunder, and whether there are notable falls of hail, without apparent and well-marked electric phenomena. (4) Mean temperature of the air before or during an electric storm, and the



M. COLLADON'S APPARATUS FOR DETERMINING THE TEMPERATURE OF RAIN DURING STORMS.

temperature of the rain which accompanies it at the very moment of its fall.

This temperature of the rain during the storms of summer is one of the interesting facts to ascertain. To this end M. Colladon has had constructed an inexpensive piece of apparatus which is very effective, and which is illustrated one-third natural size in the accompanying cut. It consists of a minimum thermometer, T T, bent like a carpenter's square, and fixed to a funnel whose axis is vertical. The thermometer is graduated at its upper horizontal part, and its lower portion passes through the funnel vertically, the bulb extending beyond the lower opening and dipping into the small receptacle, P, which collects the rain. A network, F, placed across the mouth of the funnel, protects the thermometer against breakage by the falling hailstones.

GALILEO.

To the Editor of the Scientific American:

In your number of February 15th I find an article entitled "Galileo's Museum, Florence," taken from another review, the *Pharmacist and Chemist*, published by the College of Physicians, of Chicago. Mr. H. D. Garrison, author of the letter from which you quote a long extract, may be possibly a *savant* in pharmacy and chemistry; assuredly he is not of the same competency in history. His letter is the fruit either of ignorance or of bad faith. I prefer believing him misinformed, for ignorance may sometimes be excusable, bad faith never. I have neither the intention nor the leisure to treat here at its full length the question of Galileo, still less is it my purpose to engage a controversy on a point of history at present so fully established. I shall content myself with giving the facts just as they appear from the authentic documents. (These documents are: 1st. E. Alberi, "Opere Complete di Galileo Galici," Firenze, 1842–46. 16 v. in-8vo. 2d. "Les Pièces du Procès de Galilée," publiées par H. de l'Epinois, Rome et Paris, 1877. Or 3d. 'Die Acten des Galilei'schen Processes," von Karl von Gebler, Stuttgart, 1877.) I shall then notice the principal errors laid down by Mr. Garrison.

I. Galileo Galilei was born at Pisa on the 18th of February, 1564. After having completed a brilliant course of study in the monastery of Vallombrosa, he was named at the age of 25 professor of mathematics in the university of his native city. For at least five centuries before this epoch the works of Aristotle formed the basis of all sciences. By nature a great observer, Galileo was not slow to discuss and refute the scientific doctrines of the "Master." Protestations were immediately made; and partly to escape the storm, partly to gain a higher position, Galileo solicited and obtained a place as professor of mathematics in the University of Padua. Here it was that he constructed his telescope and discovered the satellites of Jupiter (March, 1610). This discovery was greeted with the applause of all the most learned men of the time, the greater part of whom were members of the clergy, religious, bishops, cardinals. It was then that the Grand Duke of Tuscany called Galileo to Florence, and conferred on him the title of "First Professor of Mathematics and Philosophy," freeing him, however, from the care of teaching. The learned Florentine continued, by his attacks against the doctrines of Aristotle, to irritate certain minds. With a view to defend themselves, certain Peripatetics, quitting purely scientific ground, invoked texts of Holy Scripture that seemed to condemn the new system. Galileo in his turn wished to interpret the sacred text. Once placed on religious ground, the question was liable to be deferred to the Congregation of the Holy Office, which in reality took place.

At length Galileo, cited to appear, was condemned to a solemn retractation of his pretended errors and to perpetual confinement. This latter sentence was at once commuted by the Pope, and Galileo was allowed to pass the remainder of his days in his country house of Arcetri, near Florence, where it was ever permitted him to see his friends and to continue his scientific labors. It was here that, at the age of 77 years 10 months and 20 days, he gave up his great soul to God on the 8th of January, 1642.

To this brief sketch we will add two remarks:

1st. The Congregation of the Holy Office made a mistake, it is true; but that in no way attacks the infallibility of the Roman Pontiff. The Congregation has always been looked upon as a private tribunal essentially fallible, though its decisions, like those of other tribunals, have force of law from a disciplinary point of view. This is what Mr. Karl von Gebler, though a Protestant, was just enough to acknowledge in his work, "Galileo Galilei und die Romische Curie," Stuttgart, 1876.

2d. The reason for which Galileo was condemned was not, as would give us to understand certain minds systematically hostile to the Church, the hatred of science. To convince one's self of this, it is sufficient to notice with what joy the discoveries of the learned Florentine were welcomed by the Rev. Fathers Clavius, Griemberger, and Lembo, astronomers of the "Roman College," as well as by all who took an interest in the progress of science. Had the question always remained within the domain of natural science it could have been always freely discussed. The system of Copernicus, far from being condemned, was first published through the instrumentality of Card. Schomberg, Bishop of Padua, and the Pope accepted the dedication to him. It is true that even then it was attacked by a certain number of Peripatetics, but many members of the clergy were its upholders. At that time it was an open question. The Copernican system was censured only when Galileo himself was condemned and the veritable reason of his condemnation we find in a letter of Cardinal Bellarmine, who had special charge of Galileo's case: "If it be proved to us as certain," says this great cardinal, "that it is the earth which turns round the sun, and not the sun which turns round the earth, we are ready to adopt this opinion, and will agree that up to this we have not understood the Scriptures. But until such certain proofs be produced, it is our duty to hold to the traditional interpretation." (See M. Gilbert, "La Question de Galilée," Bruxelles, 1877.)

Now, Galileo was unable to furnish the "certain proofs" required by Cardinal Bellarmine and the Congregation of the Holy Office. By the motion of the earth he explained well enough the stations and retrogradations of the planets, the phases of Venus, and the principal celestial appearances, but this was by no means a physical demonstration of the reality of the hypothesis. It was sufficient to overthrow the system of Ptolemy, but did not suffice to build up that of Copernicus. Tycho-Brahe satisfactorily explained these appearances on the supposition that the earth was immovable. The principal proofs of the double movement of the earth are the deviation of the plane of oscillation of the pendulum, the displacing of the axis of the gyroscope, the deviation toward the east of a body falling from a certain height, the flattening of the earth at the poles, the existence of the trade winds, the aberration of light, the annual parallax of the stars, with all of which Galileo was unacquainted. But the most certain demonstration of all, for which Kepler prepared the way, and which was reduced by Newton to mathematical evidence in 1685, could not be made in 1615. A pretended proof based on the phenomenon of the tides was even made much of by Galileo; now, every one is aware that this phenomenon is in no way connected with the motion of the earth.

II. We shall now pass to the consideration of Mr. Garrison's tale.

He affirms that Galileo was driven from Pisa, "chiefly" by the priests, for having discovered and proved the laws of falling bodies. Now, Galileo was never driven from Pisa at all; we have said above why he left it himself to withdraw not to Florence, as says Mr. Garrison, but to Padua, where he obtained the chair of mathematics (June 26, 1592).

Mr. Garrison afterward relates how Galileo discovered at "Florence" (read Padua) the phases of Venus and the satellites of Jupiter. He then adds: "Thus in a few months the doctrine of Copernicus, regarded as heretical in the highest degree, was completely confirmed."

We have already stated that the doctrine of Copernicus at that epoch was in no way condemned, *a fortiori* it was not regarded as heretical. It was not till 1616 that the works of Copernicus were prohibited, and it was in 1610 that Galileo published his discoveries. Moreover, these discoveries, as we have said, were far from furnishing a "complete confirmation of the system of Copernicus. Here Mr. Garrison gives us reason to doubt not only of his proficiency in history, but also of his astronomical science.

"The priests," continues Mr. Garrison, "were directed to oppose the doctrine, and did so at once from every pulpit of Florence."

The truth is that a certain number of priests, of their own accord, denounced from the pulpit the doctrine of Galileo. From the beginning, as we have said, Galileo had opposers, but he had admirers as well. To quote but one authority, Mgr. Augucchi, Secretary of Pope Gregory the XV., thus wrote to him: "I am sure that with time every one will approve what you advance." (See Opere, tome 8, p. 274.) Besides priests were not alone among the adversaries of Galileo; one of the most violent pamphlets directed against him was from the pen of a Lutheran, Martin Horky. It was entitled, "Peregrinatio contra Nuncium Sidereum."

"The arguments used by them generally ran about as follows: All things were made for man, and nothing was made in vain. But the satellites of Jupiter not being visible are useless, and therefore do not exist."

I can't say whether this argument be authentic or not. At all events, it is false that this was a summary of the attacks made by the Peripatetics. An individual may have been guilty of such an absurdity, but can it be just to make all responsible for the ravings of one? It would be like judging of the merits of the Chicago *Pharmacist and Chemist* by the extract quoted from it by the Scientific American.

"In vain did the old philosopher explain and beg them (his enemies, the priests) to look for themselves. His adversaries, well illustrating the adage that 'None are so blind as those who will not see,' would listen to nothing but renunciation and denial of the alleged discoveries."

Hear Galileo himself, writing from Rome: "I am favored by a great number of cardinals, prelates, and other great personages, who have wished by themselves to verify my observations, and are in admiration of them." (See Opere, tome 6, p. 157.) And the Rev. Father Clavius, first astronomer of the Roman College, wrote to Galileo, some months after the publication of his discoveries, that he had himself seen the new planets, and added: "Verily, your lordship deserves great praise for having been the first to observe them." (Opere, vol. 8, p. 120.) Once more: It was not for having discovered and upheld the existence of the satellites of Jupiter that Galileo was condemned.

After having related to us the execution of the sentence pronounced against the great astronomer, Mr. Garrison adds: "Although his prison was his own house at Arcetri, a few miles out of Florence, still he was not permitted to leave it, even to attend church or to secure medical advice at Florence, nor was he ever permitted to see his friends until after he became blind, when this permission was graciously accorded."

To this fable history replies:

1st. He was never hindered from going to church as often as he manifested the desire. (See "La Question de Galilée," par H. de l'Epinois, p. 183, Paris, Palmi, 1878.)

2d. He was not allowed, it is true, to go himself to Florence, but he was always at liberty to call in medical aid to Arcetri. (See "Les Pièces du Procès," op. cit., p. 135.)

3d. Always, and at all times, his friends had access to him; the only restriction was, that a great number of them should

not be about him at once, lest they should appear to form a sort of academy. (Opere, vol. 9, p. 407.) And after Galileo had lost his sight the Pope sent him the greatest *savants* of the time, who noted, day by day, the thoughts of this great genius, and by conversation on his favorite studies rendered his infirmities less burdensome. He had always a secretary at his service, and it was at Arcetri that he published his principal work, the "Discorsi Mathematice," which, as he himself said, summed up the labors of his entire life. (Opere, vol. 7, p. 70.)

"At his death," says Mr. Garrison, "he was refused burial in consecrated ground, and his right to make a will was disputed."

As to the "will," it is certain that Galileo made one, which was faithfully executed. That his right to make it was disputed, I could nowhere see.

Galileo's body was deposited in the novitiate adjoining the Basilica di Santa Croce, at Florence. Mr. Garrison was, perhaps, led into error concerning the burial of Galileo by the misrepresentation of a fact which it is well to relate here, in order to have the entire truth. Immediately after his death his friends asked to erect a monument to his memory in the basilica itself. The Pope refused, on the ground that it would not look well to raise a monument in memory of a man condemned by the Congregation of the Holy Office. (See Gherardi, "Il Processo Galileo," te. doc. xxx.) But when with time minds were calmed down the remains of Galileo and his friend Viviani (probably the one whom Mr. Garrison calls "Giovanni") were transferred to the church itself. It was then, with the express authorization of the Holy Office, that the "elegant marble tomb" seen by Mr. Garrison was erected, on which may be read the following inscription:

Galileus Galileis,
Geometriæ, Astronomiæ, Philosophiæ,
Maximus restitutor
Nulli ætatis suæ comparandus.

It is worthy of remark that this epitaph, before being inscribed on his tomb, was approved by ecclesiastical authority, to which it had been submitted.

I shall not stop to refute the oft repeated charges of ignorance hurled by Mr. Garrison against the Catholic clergy. They are entirely foreign to the question, and besides are deserving of nothing but contempt. I shall not speak either of the episodes of Hypatia and Giordano Bruno, brought in no one can see why, unless to seize a chance, at any cost, of railing against the Church. These two facts are, moreover, entirely distorted. J. G. A. O.

THE NEBULAR THEORY.

PROF. BENJAMIN PEIRCE lately delivered in Boston some very interesting lectures on the nebular theory. The following is an abstract:

Force, regarded as cause, is an ideal phenomenon, suggested to recognition by the effort which we make to perform work. Invisible as the mind of man, it can only be known by its effects. The mechanical philosopher can discover nothing in it but a phenomenon of motion, and a transfer of action from one mass of matter to another. Even when a man performs a work, there is no external evidence that any exertion of the powers of mind was involved. All the physical effects are fully accounted for by the known consumption of muscular material. The mind, undoubtedly, has a controlling influence, just as the engineer controls the steam engine, or the sovereign his subjects, or the wife the submissive husband, and the work which is done is the exact equivalent of the expenditure of material. How it is that the controlling power of the mind is exerted is inexplicable. When philosophy strives to explain the inexplicable, it finds itself penned in on all sides with impenetrable mystery. But when it is content with the legitimate search for the laws of operation, the mystery vanishes like the cloud before the rising sun. When work is done, the requisite amount of physical strength is manifestly consumed; this is the law of power, which cannot be explained by other independent laws. Likewise, when man wills, his brain is heated, his arms and feet obey the intention of the will; such is the law of harmonious action, and it is sufficient to itself and to all the demands of healthy inquiry. The law of power and the law of harmony are both pre-established, and I am not aware that the boldest evolutionist has ever regarded them as the results of evolution.

There are two forms of equilibrium—the stable and the unstable. When the system, on being slightly displaced from its position of rest, spontaneously returns to it again, the equilibrium is stable; but when it diverges farther and farther from the state of rest, the equilibrium is unstable. The only possible position in which an inorganic system can remain at rest is that of stable equilibrium; whereas positions of unstable equilibrium are essential to organic structures. The equilibrium of chaos may be the unstable equilibrium of organic life.

In most nebulæ there are regions of concentration, and, indeed, every visible nebula is a concentrating mass. The gaseous nebula would be diffused if it were not held together by a sufficient attraction toward its interior. It would gradually grow faint and disappear if it were not constantly giving out light and heat by compression and condensation. It must, then, be that the attraction is more powerful than the internal elasticity. It would be extraordinary if this were not the case, considering the extreme tenuity of the nebulous substance, which is far beyond that of gas.

Prof. Peirce explained many plates of nebulæ as seen by Sir William Herschel. He disagreed from Herschel's opinion that nebulæ are remoter than clusters and stars. An interesting plate was that showing a concentrated body of matter within a ring of matter—a condition, Prof. Peirce thought, like that of our solar system, the ring representing the home of the comets and meteors. From this ring, he thinks, come the meteors which are the source of the sun's supply of heat. Views were also given of Saturn's rings (the conclusion being favored that they are fluid, and kept from freezing by the atmosphere of the planet, which probably extends to that distance, and are sustained by the planet's satellites), of curious nebulæ in the Magellanic clouds, and of spiral nebulæ.

Stars may be considered in the stages of round nebula, nebulous star, star, double star, cluster and solar system. Prof. Peirce at once proceeded to speak of the latter division of the topic, and spoke of the peculiarities of the positions of the planets relative to each other and the sun. The effect of attraction and centrifugal motion in the successive formations of the planets was explained in detail, with statements of why it is that planets increase in size from Neptune to Jupiter, and within the latter immense planet are a zone of asteroids and the smaller planets. The commensurability of the mean motions of the planets (which extends to the satellites) was also explained, and the latter part of the lecture appropriately touched upon the remarkable results which the comparatively diminutive man has been able to reach in learning the majestic truths of the universe.

The final stage of the nebular history is the planet. It may be considered under the heads of congealed star, inorganic period, organic period, planet, satellite, comet, meteor, and chaotic mass. Through the process of condensation the star must sooner or later begin to liquefy permanently, and will after a time become liquid throughout, and may be classified as a congealed star.

The planet, satellite, comet, and meteor are different forms of the congealed star. They are simultaneous in existence and not successive stages of the history. Starting from a common origin, they have passed through a process of differentiation, and are fitted for different functions. They may all be regarded as bolides, and they fill the celestial spaces with every conceivable variety of magnitude, motion, and physical aspect.

THE STRUCTURE OF THE COMET.

The perfect comet combines nucleus and train. The beauty belongs to the train, which is unsubstantial and temporary, while the mass and density reside in the almost invisible but permanent nucleus. The solid nucleus moves about the sun in a nearly parabolic orbit, obedient to the same law of attraction which governs the motions of either of the planets; whereas each particle of the train moves in its own hyperbolic orbit in consequence of a repulsion from the sun, often two or three times as great as the ordinary solar attraction. These particles are electrified bodies, and have the same electricity with the sun; the particles which are most highly electrified advance to the front edge of the tail, while those which are the least electrified fall back to the rear. Each particle seems to retain the same amount of electricity during the whole period of visibility. The theory of these hyperbolic orbits is as real a phenomenon, and subject to as certain and definite a geometry, as the planetary ellipses themselves. Their mathematical relation to the parabolic orbit of the nucleus is singularly simple to him who can read the formulæ of algebra. They conform to Kepler's two first laws, and especially illustrate the principle of the preservation of areas.

If the nucleus were to be taken away the train would continue to move off through space undisturbed by the loss. This is a singular phenomenon, but, strange to say, it has been actually observed. The nucleus is surrounded by a mist, on which account the head has been designated as coma, and hence was derived the name of comet or hairy star. The mass of the nucleus can be weighed from the height of its surrounding atmosphere, or, more exactly, the least limit of mass can be determined, which will suffice to maintain such a height of atmosphere.

In the case of Donati's comet the diameter of the nucleus was perhaps not more than a hundred miles, while the height of the atmosphere extended to eighteen thousand miles. You will be surprised to learn that the corresponding density of the nucleus was at least equal to that of iron. What an unexpected contrast is here presented to the prevalent notions concerning the sun and the comet! The solid sun is reduced by science to the state of gas, while the substance of the ethereal comet is a solid and heavy metal.

The electrification of the cometary mist is analogous to that of our own thunder cloud. Any portion of the coma which had received the opposite kind of electricity to the sun and the repelled tail, would have been attracted. This gives a simple explanation of the negative tails which have sometimes seen directed toward the sun.

DISTRIBUTION OF COMETS.

Omitting the comets with elliptical orbits, we find nothing in the position of the other orbits which indicates relation to the solar axis of rotation on the planetary planes of revolution. They are as uniformly distributed as if they had entered the system indifferently from every direction, and without reference to the internal motions of the planets on their mutual organization. If a paraboloid of revolution were constructed, with the sun at the focus, the number of the meteorites which would be contained within it during the circuit of the sun would be measured by the magnitude of its opening at some proposed great distance from the sun. Regardless, then, of the direction of the meteorites from the sun, the same area of opening would be the measure of all the meteorites or comets which would have a perihelion distance less than that of the paraboloid. Now the area of the opening is itself proportional to the perihelion distance. The inference is obvious that if all the comets and meteorites were distributed upon a line drawn from the sun, at distances corresponding to the perihelia of their orbits, the line would be uniformly covered with comets. Upon applying this law of distribution to the comets of our catalogues, we find it to be quite well enough verified to authorize its acceptance and extension to all the comets which approach the sun as near as the outermost of the planets.

NUMBER OF COMETS.

We may assume the sun's authority to extend half way to the nearest fixed star. This gives the limiting sphere a diameter exceeding one hundred thousand times the diameter of the earth's orbit; and a comet would require eight hundred and sixty-seven millions of years to pass from the regions of terrestrial visibility to these outer limits of the solar jurisdiction, and just as long for the inward passage. The number of new comets which annually appear is about three. Hence the whole number of comets which are capable of being seen from the earth at perihelion, and which at any one time, as the present, are contained within our sun's sphere, may be fairly estimated at more than five thousand millions.

MASS OF THE COMETS.

The mass is, however, more important than the number. Each comet may be assumed to be as heavy as those which have been approximately weighed, especially when it is considered that many comets must have entered the sphere of visibility and have escaped observation. Under this assumption, the mass of each individual comet exceeds, on the average, a sphere of a hundred miles in diameter with a density equal to that of the earth. Such a mass is about 1-500,000th part of the earth's mass. The aggregate mass of the comets just enumerated would then be ten thousand times the mass of the earth. This is one-fortieth of the mass of the sun and twenty-six times heavier than Jupiter.

This estimate only includes those which he calls the visible comets. A small extension of the law of distribution beyond the orbit of Neptune would increase the estimate till it became as large as the sun's mass, and would still be hundreds of times too small. The observed velocities of the comets would be totally insufficient to carry them out to the bounds of the solar territory, against the force of gravitation, subject to this immense increase; and no comet could have entered our domain and descended to visibility without having acquired a velocity far exceeding those of the observed comets. The hypothesis of the cosmical origin of the comets may be considered to have refuted itself. Notwithstanding their freedom from the peculiarities of position incident to the larger members of our group, and their consequent deficiency of family likeness, they must be adopted into it. They must be recognized as permanent associates, although their legitimate home must be placed so remote from the center that the distribution of their perihelia may manifest the law appropriate to distant orbits.

In many cases debris of comet are distributed all along the cometery path. These debris are meteorites, and are visible as shooting stars when they enter our atmosphere. They may be deflected and pass out into space; they may be burnt up by the heat arising from their concussion and rapid motion, and portions of them may fall upon the earth as meteoric stones. Pursuing their paths in groups, they give us the celebrated meteoric showers of August and September.

SOURCE OF THE SUN'S HEAT.

The sun's light and heat were derived in the outset from its compression, and some astronomers are still disposed to regard this as their source. Combustion or any form of chemical action has been abandoned by thoughtful physicists. The rival theory is that of the heat of energy derived from the concussion of the bolides, which are constantly falling into the sun. It is not as fuel that they are supplying heat by combustion, but as masses which have an energy exhibited under the form of rapid motion, and which is transformed into actual heat when they strike the sun.

Prof. Peirce discussed at length the amount of heat that would be received from meteors, and reached the following conclusions: This gives us the unexpected and startling result that the heat which the earth receives directly from the meteors is the same in amount with that which it receives from the sun by radiation. There can be no doubt of the validity of this strange conclusion, although it has not yet reached scientific publication. It is still more strange that it is verified by accurate observations made long ago by a most eminent and trustworthy authority; but which have never been discussed in relation to their significance, nor have they ever been doubted.

THE HEAT FROM SPACE.

The next point taken up was the heat received from space. Careful experiments show that this heat is only a little less than that from the sun. The earth would not give a thousandth part of it. To hold that it comes from vacant space is an untenable doctrine. It is unreasonable to assign it to the stars, for it involves too vast a difference between stellar light and heat, for the former is exceedingly slight compared with the sun. But the meteoric theory fully explains the phenomenon. The doubt is reversed, and the question arises, Why did the experiments show the meteoric heat inferior in amount to solar heat? The difference would seem to be partially caused by the penetrability of the earth's atmosphere to solar rays, whereas a large portion of the meteoric heat is absorbed into the upper atmosphere and is radiated into space before it can reach the surface of the earth, or it may show that five-sixths of the sun's heat is derived from meteors and the remainder from compression. The constant dashing of cold bolides upon the sun would cause the mighty disturbances of its atmosphere, of its surface, and the vast gaseous jets which are seen.

The bolides falling upon the sun must increase its mass at so slow a rate that many decades of centuries of nice observation will be required to detect its effects. But there are other modes in which it is not impossible that the increase of mass may be detected through the revelations of geometry. A constant increase of the solar mass would have a peculiar influence upon the planetary orbits. It would diminish their eccentricities according to a law of easy computation. Hence their orbits may originally have been quite eccentric so as to approximate them more to comets, and their present freedom of eccentricity may be the effect of the growing mass of the sun. What modification of the nebular theory may be involved in this phenomenon cannot easily be imagined without any indication from nature to guide us.

Returning to the original round nebula from which the solar system was generated, it seems to have gone through stages which are represented in many of the nebulæ. A central spherical portion seems to have concentrated into the sun and planets, leaving an outer spherical envelope, which was much slower in the process of condensation, and finally became an envelope of bolides. The natural orbit of each of the bolides was a nearly circular path, of which the sun was the center. The variety of direction of their orbits was so great that they constituted a nearly uniform system constantly approaching each other, and, by their mutual heat, producing explosion. They were thus broken into an increased number of smaller irregular masses, such as are constantly seen in the meteoric stones. In this way we find all the varieties of the bodies of the solar system harmoniously explained. Would it not be stranger than fiction, would it not violate all the physical analogies, if this ideal hypothesis of the meteoric structure of our system, sustained by such a variety of observations, were not a close representation of the actual phenomena of nature?

[Continued from SUPPLEMENT No. 172.]

RELATION OF METEORITES TO COMETS.

THUS much as to the meteors of the star showers. The sporadic meteors are with good reason presumed to be (and observed facts prove some of them to be) the outliers of a large number of meteoroid streams, and the leading problem of meteor science to-day is to find these streams so faintly shown, and, if possible, the comets they belong to.

Come back with me to the November stream and its comet. The several bodies move along a common path not at all by reason of a present physical connection. They are too far apart, in general a thousand times too far apart, to act on each other so much that we can measure the effect. No; their connection has been in the past. They must have had some common history.

Looking now at the comets, we see that they have been apparently growing smaller at successive returns. Halley's comet was much brighter in its earlier than in its later approaches to the sun. Biela's comet has divided into two, if not more than two, principal parts, and seems to have entirely gone to pieces. It could not be found in 1872 when and where it ought to have been visible. Several comets have had double or multiple nuclei

In the year 1366, in the week after the star shower, a comet crossed the sky exactly in the track of the meteors. A second comet followed in the same path the week after.

Both belonged no doubt to the November stream, and one of them may perhaps have been the comet of 1866.

This string of meteoroids is a long thin one. In miniature it would be perhaps a mile long to an inch in thickness. We have crossed the stream at many places along a length of a thousand millions of miles, sometimes in advance of and sometimes behind the comet, and all along this length have found fragments, sometimes few, sometimes many. This form of the stream suggests continuous action producing it. A brief violent action might give this form, but a slowly acting cause seems more natural.

Again, in the history of Biela's comet we have distinct evidence of continued action. The comet divided into two parts not long before 1845, and yet in 1798 fragments of it were met with so far from the comet, that they must have left the comet long before, probably many centuries ago.

Thus we are led to say, first, that the periodic meteors of November, of August, of April, etc., are caused by solid fragments of certain known or unknown comets coming into our air; secondly, that the sporadic meteors, such as we can see any clear night, are the like fragments of other comets; thirdly, that the large fireballs are only larger fragments of the same kind; and finally, that this stone, which was broken off from one of those large fragments in coming through the air, must once have been a part of a comet.

Here I should naturally close, yet I am sure that you will ask, How came the comet to break up? Perhaps the prior question would be, How came the comet together? In its history there is much that we cannot yet explain, much about which we can only speculate. Thus, how came this stone to have its curious interior structure? As a mineral, it resembles more the deepest fire-rocks than it does the outer crust of our earth. It seems to have been formed in some large mass, possibly in one larger than any of our existing comets. Some facts show that the comets have almost surely come to us from the stellar spaces. Out somewhere in the cold of space a condensing mass furnished heat for the making of this stone. The surrounding atmosphere was unlike ours, since some of these minerals could hardly have been made in the presence of the oxygen of our air. Either in cooling, or by some catastrophe, the rocky mass may have broken to pieces, so as to enter the solar system, having little or no cohesion, like a mass of pebbles; or it may have come, and probably did come, a single solid stone. In either case, as it got near to the sun, new and strong forces acted on it. The same heat and repulsion that develops and drives off from a comet in one direction a tail, sometimes a hundred millions of miles long, may have cracked off and scattered in another direction solid fragments. One of these contained in it this stone, and it wandered in its own orbit about the sun, itself an infinitesimal comet, how many thousands or millions of years we know not, until three years ago it came crashing through the air to the earth in Iowa. Thence this fragment came here to serve as a text to my discourse.

[Continued from Supplement No. 172, page 2743.]

ARCHÆOLOGICAL EXPLORATIONS IN TENNESSEE.

By F. W. Putnam, Curator of the Peabody Museum.

Fig 39 represents a potsherd taken from one of the graves. This is probably a portion of a small bowl, and is an attempt, it seems to me, at a reproduction of the head of a bat, the features of which are more apparent in the fragment than in the figure.

Pieces of mica were also found in one of the graves, and

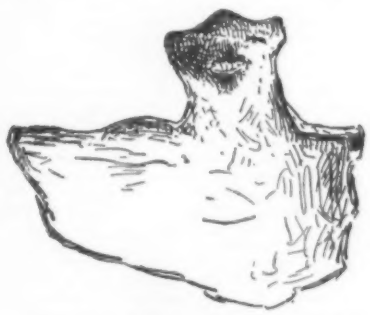


Fig. 39.—FRAGMENT OF POTTERY FROM GRAVE, BURIAL MOUND WITHIN EARTHWORK. NATURAL SIZE.

in another was a pipe carved from a dark slate (Fig. 40), which is of interest from its resemblance in form to pipes of recent manufacture.

In the earth, between the graves, numerous fragments of pottery and a few perfect vessels were found. In one of the pots were two of the shell spoons of which mention has been

Fig. 40.—PIPE MADE OF SLATE, FROM GRAVE, BURIAL MOUND WITHIN EARTHWORK. NATURAL SIZE.

made in another place. A discoidal stone was also obtained. Between two of the graves, nearest the surface, was found the interesting pipe carved from green steatite, and representing a man holding a cooking vessel, which forms

Fig. 41.—PIPE CARVED FROM STEATITE, FROM BURIAL MOUND WITHIN EARTHWORK.

the bowl of the pipe, the hole for the insertion of the stem being in his back. The three views given in Figs. 41, 42, and 43, will convey a better idea than words of this interesting relic. The lower portion of the figure is left unfinished, as if that part had been inserted in a base of some other material, which is also indicated by the hole in the stump of the right leg.

Fig. 42.—SIDE VIEW OF FIGURE 41.

Scattered irregularly within the inclosure are nearly one hundred more or less defined circular ridges of earth, which are from a few inches to a little over 3 feet in height, and of diameters varying from 10 to 50 feet. The best defined of these little mounds was that marked B on the map. An examination of these numerous low mounds, or rather earth rings, as there could generally be traced a central depression, soon convinced me that I had before me the remains of the dwellings of the people who had erected the large mound, made the earthen embankment, buried their dead in the stone graves, and lived in this fortified town, as I now feel I have a right to designate it.

Nineteen of the best defined of these earth circles were carefully explored with very gratifying results, and proved to my satisfaction that the ridges were formed by the decay of the walls of a circular dwelling, about which had accumulated, during its occupancy, such materials as would naturally form the sweepings and refuse of a dwelling of a people no further advanced toward civilization than were these mound builders of the Cumberland valley. These houses had probably consisted of a frail circular structure, the decay of which would only leave a slight elevation, the formation of the ridge being assisted by the refuse from the house.

After the recent soil within the ridges had been removed,

Fig. 43.—BACK VIEW OF FIGURE 41.

hard floors were discovered upon which fires had been made; while in the dirt forming the ridges were found fragments of pottery; broken and perfect implements of stone, several discoidal stones, most of which were made of limestone; bones and teeth of animals; charcoal, etc.

On removing the hardened and burnt earths forming the

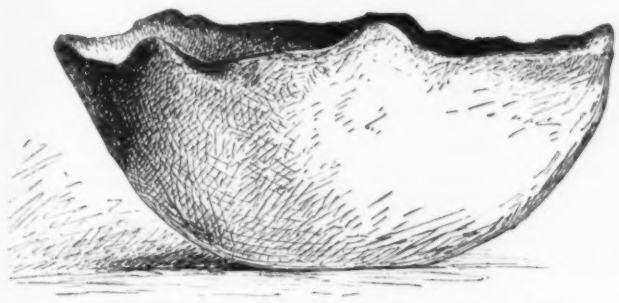


FIG. 45.—BOWL FROM REFUSE OF A HOUSE WITHIN EARTHWORK.

FIG. 48.—POT FROM GRAVE OF CHILD IN A HOUSE WITHIN THE EARTHWORK.

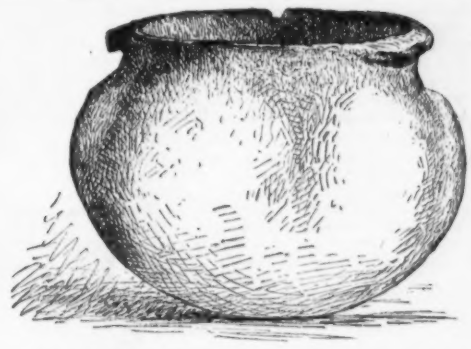


FIG. 51.—POT FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

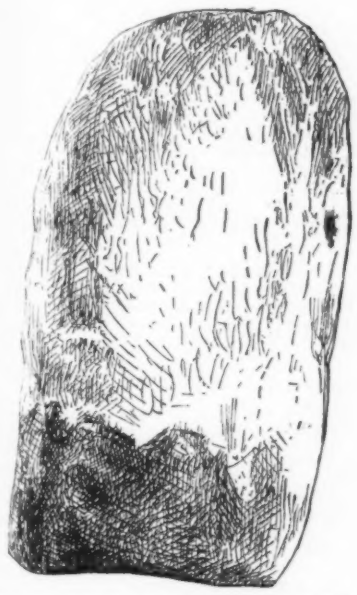


FIG. 46.—CELT OF SANDSTONE FROM RIDGE OF HOUSE WITHIN EARTHWORK. NATURAL SIZE.

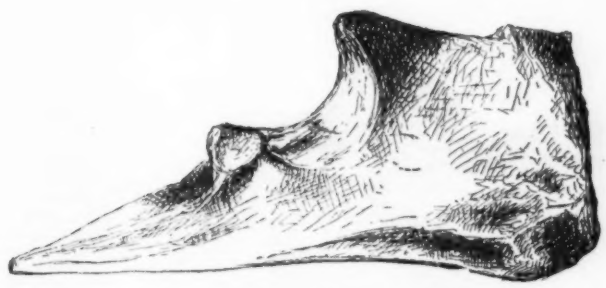


FIG. 49.—IMPLEMENT OF BONE, FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK. NATURAL SIZE.

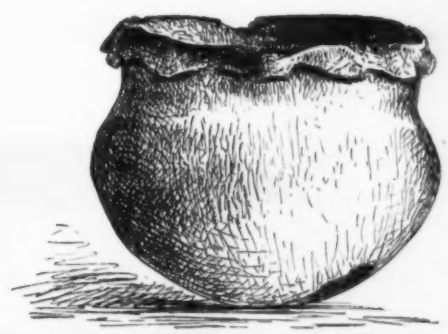


FIG. 52.—POT FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

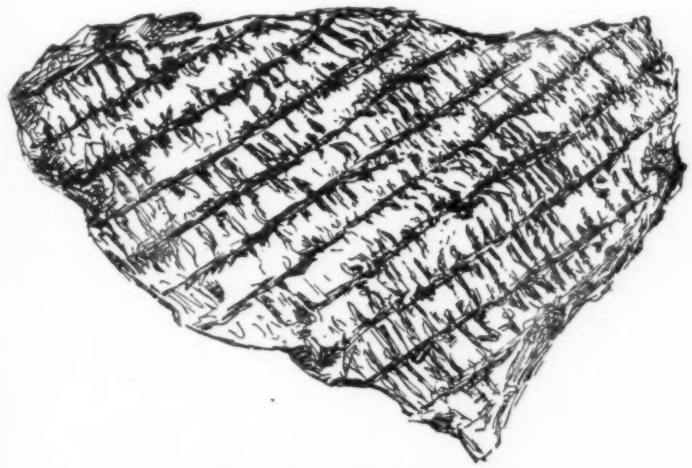


FIG. 44.—FRAGMENT OF POTTERY FROM REFUSE OF A HOUSE WITHIN EARTHWORK. NATURAL SIZE.

FIG. 47.—DISH FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

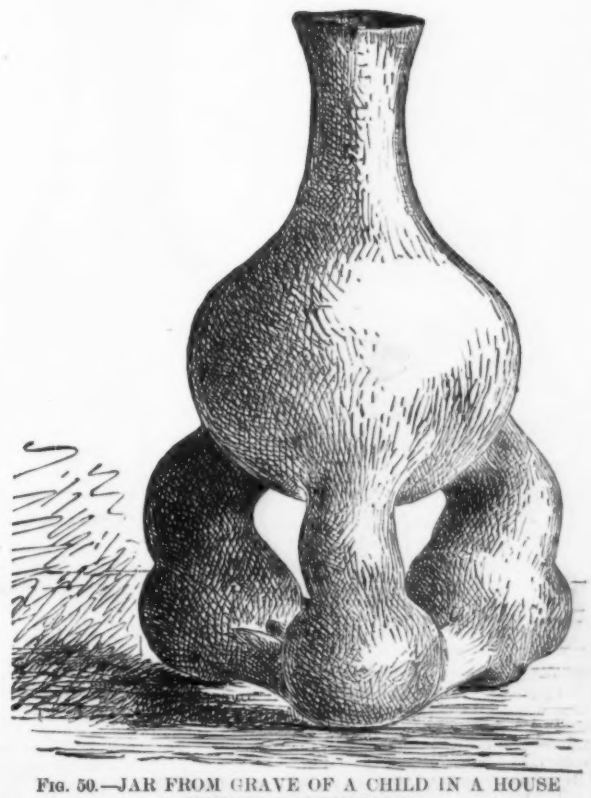


FIG. 50.—JAR FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

floors of the houses, and at a depth of from one and a half to three feet, small stone graves were found in eleven of the nineteen circles that were carefully examined. These graves were in every case those of children, and were from one foot to four feet in length. In some the bones were entirely decayed, in others a few of the more solid parts of the skeleton, such as the shafts of the long bones, the central parts of the vertebræ, and fragments of the crania, were preserved.

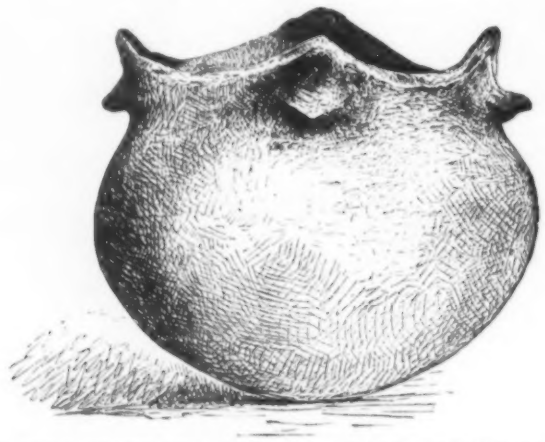


FIG. 53.—POT FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

The tibiæ of one young child in particular are worthy of remark from their extreme thickness and great curvature. These tibiæ of children are not in the least flattened, though some of the tibiæ of adults from the burial mound are.

These children's graves were found at one side of the center of the house, and generally, it was noticed, that a fire had been built over the spot, as shown by the burnt earth and charcoal. From them were obtained the best specimens of pottery found within the earthwork, with shell beads, pearls, and polished stones of natural forms, etc., which were probably playthings. In several of the smaller graves were the metacarpal bones of birds, which may have been given to the children to aid the teeth in perforating the gums, as is stated to be the custom among some of the present Indians.

Three small discoidal stones were picked up in the ridges of as many different houses, and one other was found on the hard floor, while still another was discovered in the burnt earth over a child's grave.

In the dirt forming the ridge of the house designated as No. 3 in my notes, and under the floor of which graves were not found, was a fragment of thick pottery (Fig. 44), with the impression of a closely woven fabric of coarse threads. Near this was taken out a bowl with rudely scalloped edges, of which Fig. 45 is a representation. From the same place was also taken a rude celt (Fig. 46), made of sandstone.

Under the floor of one of the houses was a small grave containing the remains of the bones of two children, and with them the dish, of which Fig. 47 is a drawing. No other article was found in this grave, over which a fire had been made, and in the ashes were burnt animal bones, a discoidal stone, and several fragments of pottery.

Within the area covered by another house, three burials had taken place, and from these graves were obtained two earthen vessels, a discoidal stone, a dish, and a few shell beads.

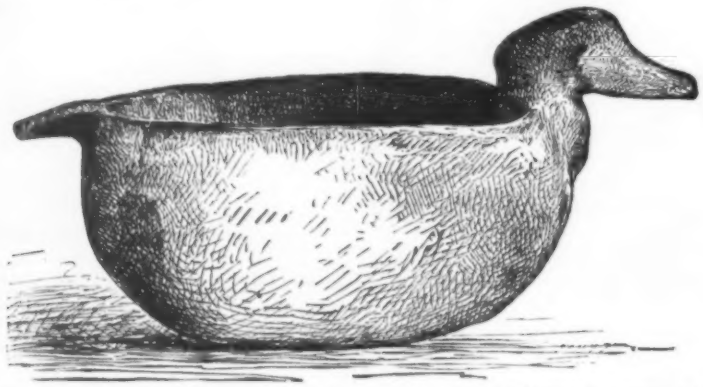


FIG. 54.—DUCK-SHAPED DISH FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

Three other houses contained graves of children, in which were found several articles worthy of note, and evidently of considerable value. Under the floor of one of these houses two graves were discovered, one of which was made simply by placing two stones about eight inches apart, and was without the usual pavement at the bottom, or the covering and end stones. This contained the remains of an infant buried in ashes, though the bones were not burnt, and two broken vessels of ordinary form.

FIG. 55.—PAINTED JAR, FROM GRAVE OF A CHILD IN A HOUSE WITHIN EARTHWORK.

In the other grave was a similar vessel (Fig. 48), an awl, or pointed implement of bone (Fig. 49), and another made of deer's horn, the leg bone and a vertebra of a bird, and five shells of *Unio*.

Another house, located near the large mound, contained two graves, in one of which was found a water jar mounted on three hollow legs, the cavities of which connect with the body of the jar, while the cross bars between them are solid. The jar is shown, of one-half its diameter, in Fig. 50.

The other grave in this house was remarkably rich in relics, and contained an earthen pot, a bone of an animal, the shell of *Unio*, two large shells of *Busycon*, from the Southern Atlantic coast, from which the columella had been removed, and a large lot of small shell beads, of which six hundred and fifty were collected and many more were in fragments. These beads would have formed a chain several feet in length, as one hundred of them measure eighteen inches. With these shell beads were seven perforated pearls of large size, among them one which is nearly half an inch in diameter, also several handsome pebbles of quartz, chalcedony, etc., and a piece of the stem of a fossil crinoid.

The last of the houses examined, which was also located near the large mound, contained the graves of an infant and of two other children. In the grave of the infant, the only article found was an earthen pot, represented by Fig. 51. The second grave contained a dish, and the small pot with ornamented edges, shown in Fig. 52. The third grave was remarkable for the three well made articles of pottery which it contained. These are represented, of one-half their diameter, by Figs. 53, 54, and 55. The pot shown by Fig. 53 is a symmetrical vessel, with deeply scalloped edge and with a projecting portion under each point of the scallop. Fig. 54 is a well executed design of a duck-shaped bowl, while Fig. 55 represents a water jar in the form of a bear. This last is the only article of pottery obtained within the inclosure at Greenwood that was not of the ordinary blue gray color, like the majority of the pottery from Tennessee, Missouri, etc. The surface of this jar is of a yellowish color, and on this had been painted a number of concentric figures, which were perfectly apparent when the jar was first removed from the grave, but, as they had not been burnt in, they scaled off in drying and are now only faintly indicated. This interesting jar, with others that are here figured, is evidence of the high attainments of this ancient people in the ceramic art, and shows the development reached in native art by people who worked in copper, carved in stone and shell, moulded in clay, wove fabrics of several kinds, cultivated maize, lived in walled or fortified towns, buried their dead in an extended posture, generally in stone graves, and erected the large mounds of the Cumberland valley, from which they are now known as the Mound-builders.

THE GEOLOGY OF COAL.

PROFESSOR GREEN, of the Yorkshire College of Science, and many years connected with the Geological Society of Great Britain, a few days since delivered an able and interesting lecture on the "Geology of Coal" at Barnsley to an appreciative audience. It is well known that two theories have been advanced with respect to the formation of coal, one assuming its origin to be the driftwood carried down by the streams and embedded in estuaries, and the other that the vegetable materials grew on the spot where they are now found in the form of coal. The latter is entirely in harmony with the phenomena found in connection with the coal measures, the vegetable origin of which we may say was recognized so far back as 1785 by Hutton, as given in his "Theory of the Earth." Professor Green commenced by stating that England has changed very much during the comparatively short period that was covered by human history. Two thousand years ago this country was a wild trackless waste, but now everything was altered, for they had highly cultivated lands, means of transport by railways, rivers, sea, and canal. These had materially helped in bringing the country to its present position—one of the most densely populated spots on the earth, and one of the busiest to be found in the world. During the early period of the world's existence sea and land had changed places over and over again, and this country had participated in those changes. That period, however, was so immensely removed that no human pen had recorded what the country was then like—yet records had been given them as accurate as any human chronicle could have furnished. In the ancient cities long since gone to decay the ruins of the houses, domes, and monuments still remained, and were preserved, and learned men had set to work to find out what kind of people had inhabited those cities, and their manners and customs. Now, from time almost immemorial men had been engaged in almost similar work. But they must not suppose that the whole of the earth was of the same age, or that the rocks were as they are now found, for many of the latter contained the remains of great animals of the sea showing their connection. But there was one special group of rocks to which he would draw attention, and it consisted of sandstone, shales, limestone, and coal. They were so formed that they needed but little description. Shales were nothing in the world but hardened mud. Take a piece of it and let it lie in the garden, or put it into a basin of water and stir it up well, when it would soon settle down into mud. Were they to go into a quarry or any place where sandstone was kept they would find it was divided into pieces or lumps, and these layers would range from 15 to 20 feet in thickness, one above the other, like so many volumes of books, one on top of the other. This was known as stratification, and the beds as stratified. Let them take a small pond or lake into which rivers or streams emptied themselves. The water took down sand and mud, which sank to the bottom, and in the dry weather it settled. The layer was thus hardened, and when the next layer came a distinction was marked between the two. It was, however, evident that shales and sandstones were formed in that way. Limestone rocks were composed of carbonic acid and lime. Many limestones were extremely hard solid rocks, some of which could be as easily dissolved by water as sugar or salt, not by pure water, however, but by water that held carbonic acid on its surface, and of this they got very inconvenient proofs in the state of their tea-kettles. Coal lay among these shales and sandstone, and if they were to go into a colliery, or any place where coal was stored, and broke it, they would find that it gave way in pieces cubical in shape. It would give way in three directions, two of the directions being at right angles to the bedding of the shales and sandstone.

Coal was principally composed of mineralized vegetables, and Dr. Dawson, who had minutely examined coal at home and in Nova Scotia, came to the conclusion that a greater portion of the latter was composed of the bark of the sigillaria. He did not say that the whole of the coal was so formed, for in some cases he found traces of plants. He divided the coal into three parts—mineral charcoal, the sigillaria bark, and the leaves, twigs, and stems of herbaceous plants. A very large portion of our English coals was made up of parts of plants different from those of Nova Scotia coal. The well-known lepidodendron, which held a large

number of minute bodies of spores, was related to the club moss, which grows in the marshy portions of the country, and which also produced spores; and here it may be said that at the present time there are no living representatives of the sigillaria and lepidodendron, the presumption being that the climate where they existed was not of an equatorial character, but warm and moist, and never extreme, something like that of New Zealand. With respect to the spores of the club moss—which had been shown by Brogniart to be a representative of the lepidodendron—Prof. Green produced a small bottle containing spores, and on applying a match to it the contents exploded in a similar manner to gunpowder, without any report whatever. Stuff like that, the Professor remarked, was evidently the material well adapted for transformation into good coal, and no doubt did so. If they obtained a slice of such coal they would find a number of ringed patches of a yellow color, and if it was cut at right angles to the top and bottom of the coal they would see a number of flattened rings, showing the progressive formation. Coal, then, may be said to be principally composed of the fruit of the lepidodendron, there being found in it myriads of minute spores, while the sigillaria, which has contributed more than any other to the production of coal, is a member of the family of the lepidodendron.

The club moss, too, had a cloud of spores in a single spike, that one would not expect from its tiny size and appearance, yet it took its part in the formation of coal, although they might think that the supply of spores would soon be exhausted. The lepidodendron was just the opposite; it had been a forest tree growing to a height of nearly 100 feet (one specimen from the Jarrow Coal Mine was 40 feet in length and 13 feet in diameter near the base). Let them, continued the professor, imagine forests and forests of these trees, and they might then understand that the supply during the period before coal found was almost inexhaustible. There were two points which were peculiarly characteristic of good coal. First its purity, and the absence of anything that could not have had vegetable origin. If good coal was burned there would be a little ash left, which in all probability was nothing more than the ash of the original wood. Then came its extraordinary thickness in some places, as, for instance, some of the coal in Yorkshire. There was the silkstone, which covered a superficial area of hundreds of miles; it was evident it could not have been formed in the same way as layers of sandstone. The deposit on which it was formed was not vegetable matter, but mud; and suppose they had a vast swampy piece of ground covered with vegetation, each plant as it died would form a layer of bad vegetable matter. Let this go on for years—probably for centuries—and there would be no limit whatever to the vegetable matter accumulated. There would then be nothing whatever to introduce any improper mixtures in the shape of sand or clay into the matter so formed, and so the coal was formed.

In conclusion, Prof. Green alluded to the cannel coal, principally found in the Wigan District and some parts of North Wales, which he considered was formerly the plants brought down the rivers into the ponds or lakes, and ultimately formed a deposit after the water had been absorbed. A cordial vote of thanks was accorded to Mr. Green for his interesting and able lecture.—*Mining Journal.*

THE ROBIN.

By MARY E. HOLMES.

I HAVE a pet robin nearly eight years old, which fell from its nest before it was fledged. It never has been known to beat against the wires of its cage in any way. On the contrary, when allowed to fly out, it is ill at ease, permitting itself to be caught without difficulty, and seems as glad to get back as a child to return home from boarding-school. At first we fed him on spiders, earthworms, and such larvæ as could be obtained, but very soon he manifested a marked preference for beef-steak, and took very kindly to bread, crackers, bread and milk, cake, etc. For the last seven years, his "living" has been anything ordinarily found upon the family table, he having become altogether too aristocratic to stoop to common robins' food. During his first winter, whenever the cook was frying doughnuts, we noticed a peculiar, teasing note, uttered only when he was specially anxious for some new kind of food. This led us to try his taste for *hot* doughnuts, when we found they exactly suited him, and the hotter the cake, the more voraciously did he eat it. As a further test of his power of scent and peculiar taste, we found that as soon as a paper of raisins or any such fruit was brought into the room, though it had not been opened he began teasing, just as a cat perceives the arrival of fresh meat while it is still wrapped in the paper. For any kind of meat, fresh or salt, boiled or fried (save mutton), he shows evident pleasure, and though retaining his regard for flies and spiders, he is not at all anxious for them. In the summer, when his cake becomes too dry to suit his palate, he dips the whole bit into his bathing dish to moisten it; nor is this merely accidental, for the dish stands at the farther side of the cage, and it is a custom with him to carry it and dip it in. As a result of his soft diet and peculiar life his bill has a projection upon its point at least three-sixteenths of an inch long, and the nails of his hind toes, if straightened, would be considerably more than an inch long.

During the hot weather, it is no unusual thing for him to bathe thoroughly five or six times daily, often as late as after tea, and very generally his good-night song is sung by gaslight; indeed, during the early winter months he often sings till 10 P.M. During January and February his notes are very soft and sweet, becoming louder and louder as the season advances, until the first or middle of July, when, during the process of moulting, he is silent—save the welcoming chirp which is ever ready—until the middle or last of September. During this time there are many days when he has no perceptible tail or wing feathers, and not more than half a dozen on his head and neck. Whether or not this shedding of so many at once is due to his food and surroundings, I cannot say, but it has ever been so.

As regards his notes, never having been with other robins, and frequently hearing the tones of the piano, his song is so much of a medley that persons passing very often exclaim, "What kind of a bird is that, a mocking bird or a parrot?" and will hardly believe him only a common redbreast. When hung out of doors during the summer, other robins are attracted to his cage, frequently alighting upon it, but he never seems to pay the least attention to them. If, at any hour of the night, be it never so dark or light, a member of the family passes through the room, he always greets the footstep with a cheery welcome; but let a stranger do the same, he gives no sign of recognition. For persons, also, he has a marked preference—seldom changing his first impressions, even upon acquaintance, and upon being courted to do so by many tempting morsels. His dislike is manifested by a peculiarly sharp *quip, quip,* and by running into the farthest corner of the cage and turning his back upon the interloper—not in a manner indicating fear, but rather defiance. Moreover, if he is singing never so merrily, the entrance of the person he dislikes checks it all, and he even refuses to eat, unless starved to it, until he leaves the room.—*Science News.*

A NEW ENEMY OF THE GRAPEVINE.

THE excitement caused throughout the wine growing districts of Europe by the devastations of the phylloxera has hardly subsided, when another enemy of the grapevine appears and causes no little consternation among the wine growers of Austria at least.

Mr. H. Goethe reports in the *Wiener Landwirthschaftliche Zeitung,* the appearance in the neighborhood of Gurkfeld, Krain, Austria, of large numbers of caterpillars infesting the vineyards and destroying the young buds and leaves.

They were first observed in the beginning of May. They were about 0·04 inch in length, very lively and voracious (Fig. 1). Apparently they developed from eggs laid in the preceding fall, under the epidermis of the branches.

A number of them having been collected and sent to Mr. Goethe, he placed them into a salt mouth bottle, closed by a perforated piece of pasteboard. At first sight, Mr. Goethe mistook them for the larvæ of a very common moth which lives on the grapevine, but is comparatively harmless. The difference, however, was soon demonstrated by the great voracity of the animal, which not only devoured an extremely large quantity of leaves, but also partook of the buds and choicest young leaves only. They differed decidedly from the animals they had been mistaken for by the habit of attacking a leaf at the center and extending the hole toward the edge (Fig. 2).

When received by Mr. Goethe the caterpillers were 0·16 inch long. They were of a light brown color, and lined with darker stripes along the back and sides. The belly and the feet, of which there were 16, were white. The neck was somewhat darker than the rest of the body and quite glossy.

Each ring of the body was provided with a bunch of stiff hair.

Besides their color and habits they differ from the larvæ of the tortrix, the ordinary grapevine moth, by their early appearance. They are also less affected by being exposed to direct sunlight, and enjoy a by far better appetite.

FIG. 1.

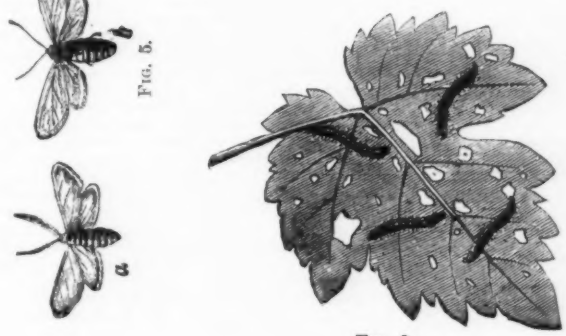


FIG. 2.

FIG. 5.

FIG. 3.

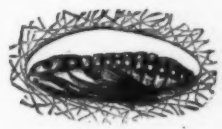


FIG. 4.

Ino proeris ampelophaga.

A NEW ENEMY OF THE GRAPEVINE.

About the middle of May the caterpillars became quite restless. They wandered about as if in search of some shady spot to retire to. They finally attached themselves to the pasteboard cover and wove a thin tissue around themselves. From this, about a week afterward, the caterpillars emerged again, clad in a new, more brilliant skin, the old one being left behind. They were now very vivacious, and their appetite had yet considerably increased. Toward the end of May they were over 1½ inch in length (Fig. 3). They now attached themselves again to the cover, and a second cocoon was soon formed. This time it consisted of two layers, between which a dense layer of white dust was found to be embedded.

On opening one of the cocoons the chrysalis was found perfectly developed. It was of an orange yellow color, and provided with a short spur on the lower side (Fig. 4).

The butterfly emerged from the chrysalis the 27th of June. Fig. 5 shows, in natural size, in A and C, males with spread and closed wings respectively. Fig. 5, B, shows a female. Both are of a dark brown color with metallic luster, and the wings are lined with feathery fringes. The head and throat are green, while the belly, abdomen, and back are brown.

The butterflies were quite lively, and propagation took place as in liberty. The females laid from 80 to 1·0 eggs of a yellowish white color, beneath the stems of the young leaves. A few days afterward the animals died.

Specimens having been sent to Dr. H. Nördlinger and the Imperial Agricultural Station at Klosterneuburg, the moth was determined to be *Ino proeris ampelophaga.* Mr. Goethe did not succeed in obtaining any larvæ from the eggs laid by the moths, but it is probable that a second generation hatches in July or August, which deposit their eggs beneath the epidermis of the young branches in fall.

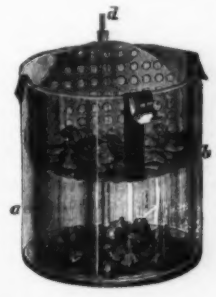
It has since been ascertained that this insect appeared simultaneously in Hungary, Slavonia, Siebenbürgen, and Krain, and has caused considerable losses. So far no means for protection have been recommended beyond collection and destruction of the eggs and larvæ and the branches affected.

THE ANATOMY OF THE MALE CHIMPANZEE.

In dissecting a male chimpanzee that died lately in the Zoological Garden at Philadelphia, Dr. Joseph Leidy has discovered several hitherto undetected peculiarities. It is certain that they did not appear in the structure of the female specimen recently dissected by Dr. Chapman. That gentleman found the chimpanzee brain to clearly resemble the brain of man, with the exception that the cerebrum did not cover the cerebellum. This coincided with the report of a distinguished anatomist who dissected a chimpanzee many years ago. Dr. Leidy, however, finds that in the male chimpanzee the cerebrum does cover the cerebellum, indicating a greater brain power in the male than in the female; and he infers, accordingly, that the anatomy of the male chimpanzee has never before been examined and reported on. Dr. Leidy also finds the vocal organs of the male to differ greatly from those of the female, particularly in the possession by the male of a natural bagpipe, communicating with the larynx, and extending to the breast and into the arm pits. This cavity is covered by powerful muscles. For the animal to increase the power of his voice it is obvious that only a slight motion of the arm would be necessary. On discovering this singular physical arrangement the Professor wrote to the superintendent of the Zoological Garden to inquire if the male chimpanzee had any distinctive call or cry, to which the superintendent replied that the 'voice of the male, for so young an animal, was simply enormous; its cry when enraged was loud, piercing, and shrill." It is a well-known fact, says Dr. Leidy, that this vocal arrangement is found in the male gorilla, the orang-outang, and the howling monkeys of Southern Africa, whose cry can be heard for miles.

DR. S. M. PLUSH BATTERY CELL.

THIS battery cell is a modification of the Callaud battery, and consists of the glass jar, *a,* of the usual proportions, having at the bottom a copper plate, upon which is placed sulphate of copper, and has attached to it the insulated wire, *d,* forming the positive pole. About half-way down the inside of the glass jar is the shelf, *b,* a perforated sheet of copper, upon which is placed pieces of zinc of any form. The shelf is suspended by three strips of copper, one of which, *c,* constitutes the negative pole. With this form of cell, the zinc of commerce can be broken into pieces of suitable size and used without any other preparation, and the zinc can all be consumed; while in the Callaud battery, the zinc must be cast into suitable form, involving some loss of metal and expense, and as a considerable percentage of the zinc of such castings is not consumed, it must be remelted at still further loss. Another advantage is that the sulphate of copper can be fed into the bottom of the cell through the opening left by turning up one side of the shelf, *b,* and broken zinc placed upon the shelf, without disturbing any of the connections, thus making the battery absolutely continuous. Ob-



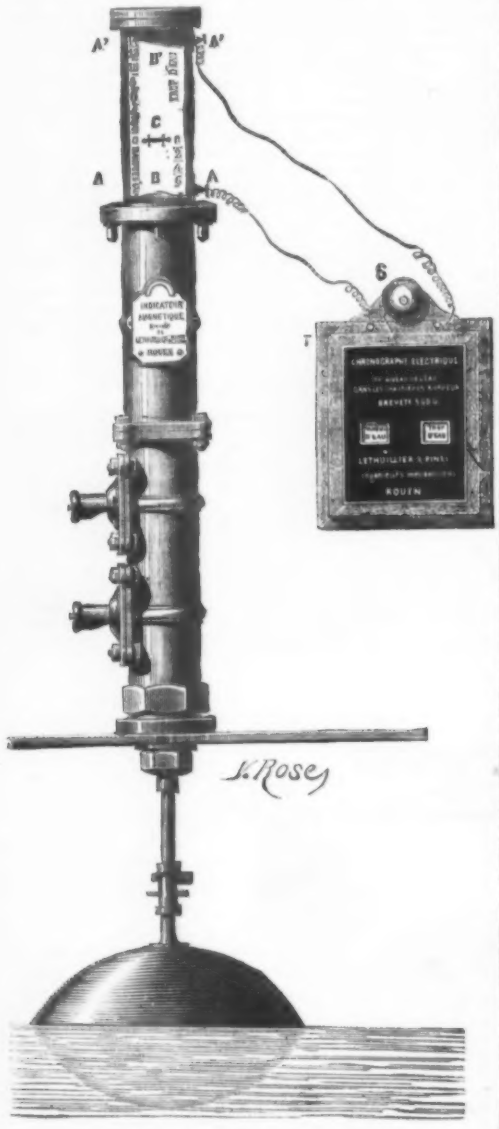
jection has been urged that there will be local action between the zinc and the copper of the shelf, but Dr. Plush holds that practically no such action can take place, as there is really no closed circuit between the pieces of zinc and the copper. Lead may be substituted for copper in making the shelf, *b.*—*Journal Frank. Institute.*

ELECTRIC CHRONOGRAPH FOR STEAM BOILERS.

M.M. LETHUILLIER & PINEL have recently made important additions to their magnetic indicator, by means of which the water level in steam boilers may be ascertained at any distance.

The apparatus on exhibition at the Paris Exhibition consists of an indicating tablet, T, which may be placed in any part whatever of the establishment, however remote; as, for instance, in the office of the engineer, that of the superintendent, or within reach of the boiler inspector. This

tablet is connected with the magnetic indicator by two electric wires. At the lower part of the dial of the indicator are placed two pieces of copper, A, and upon each of these is fastened a platinum plate, B. These platinum plates are superposed at a distance of about two millimeters. When the index, C, descends, it rests on the upper piece of platinum, depresses it, and puts it in contact with the lower. An electric current is thereby established, the bell, S, rings,



ELECTRIC BOILER INDICATOR.

and, at the same time, the sign "*Low water*" appears on the tablet. Similar pieces of copper and platinum are fixed at the upper part of the dial; and, when the index reaches this limit, the bell rings, and the indication "*Too much water*" turns up on the tablet. In order to remove the warning words from the tablet, a button is pressed, which returns the indicating parts to their normal position.

THE ATLANTIC AND PACIFIC INTEROCEANIC CANAL.

To the Editor of the Scientific American:

It is now twenty-two years since I had the honor of reading before the Institution of Civil Engineers, London, a paper "On the Junction of the Atlantic and Pacific Oceans and the practicability of a Ship Canal, without Locks, by the Valley of the Atrato," and the President, Robert Stephenson, M.P., then remarked, with the kindness and urbanity that distinguished him, "the Institution was much indebted to Mr. Kelley for his highly interesting paper, which had induced the expression of valuable opinions," and concluded with the following words: "A few years longer would probably decide, whether it was feasible to make an interoceanic canal; at any rate it could not fail to be remembered that Mr. Kelley had produced more intelligible information upon the subject, than had hitherto been given to the world." In view of those opinions of a deeply lamented and great man, I hope I shall not be deemed presuming too much on them in venturing to call the attention of your readers to the advantages of constructing a ship canal *via* the San Blas route, surveyed under my direction in 1864, by Mr. A. McDougal, chief engineer. I offer them to you in hopes that their publication may suggest to the English people that a short and safe route for a ship canal through the American isthmus can be secured for European commerce to Australia, New Zealand, and all the trading ports in the North and South Pacific Ocean, and which may be preserved strictly neutral, under the joint protection of England and the United States—the two great English speaking nations, enjoying the same religion, reading the same literature, maintaining the same liberty, and practicing the same laws; therefore they ought to go hand in hand in the execution of the work.

Great projects seldom die. When once any considerable number of men become convinced of the importance and utility of an enterprise, however vast, it is considered and discussed from year to year, from generation to generation, and from age to age, until the time, the facilities for execution, and the men are collected together, and the work is accomplished. The Suez Canal is a striking example. From the earliest days of modern commerce a strong desire for its construction prevailed among commercial men. Its supposed impracticability stimulated the search for water routes, resulting in the discovery of the capes and the American continent. Prior to these events, the commerce of the East, depending upon the transit by land, centered in and made the greatness of the Mediterranean republics and kingdoms. They were the mariners and commercial nations of the world at that epoch. After the discoveries of Vasco da Gama and Columbus, the enterprise and hardihood of northern nations, especially the English, rapidly developed their maritime power, and after various events, the empire of the seas remained almost without dispute in the hands of the inhabitants of the British Isles. With that, and the advantages of the sea route (as long as it was *via* the capes), came the control of the eastern commerce, and England became the entrepot for its distribution over Europe. Conquest of eastern territory, wealth and power, soon followed, and the enterprise of the Anglo Saxon race being equal to the occasion, they have kept what they won until the present time.

The peaceful successes of commerce have done more for England's greatness and supremacy than achievements in war, and in the various complications of European politics, the protection of British eastern commerce is very clearly the chief end and aim of the Government. Even during the recent eastern war, which Turkish misrule and Russian ambition kindled, that has palpably and avowedly been the principal object of British statesmen. England has acquired a large interest in the Suez Canal, and if absolutely necessary, she would fight for its control, and yet, even if she assumed the protectorate of Egypt and the supreme control of the canal, it is very doubtful if they could be so managed as to sustain the supremacy of British commerce in the East. When the enterprise was advocated twenty years ago by M. Lesseps, who carried it to completion, he met with scanty encouragement from British capitalists and statesmen. Lord Palmerston, and a large number of other influential and prominent men, were opposed to the project, and they doubtless foresaw the effects which are now in process of development, and which are surely injuring British commercial interest in a continually increasing degree. Time and money are the two great elements in commercial economy, and the preponderance of either one in certain proportions will surely settle the course of trade. While the great advantages of economy in transportation from the East remained with the route by Cape Good Hope, the control of such commerce was certainly in the hands of British merchants, and all the products of the East were taken to England for distribution, and all the Continental nations paid her a corresponding tribute.

The Suez Canal and steam are changing all this in no small degree, as the Mediterranean ports still exist, and lines of steamers from Marseilles, Geneva, Trieste, and other ports are already bringing eastern products directly to the littoral countries of the Mediterranean. The northern nations are completing their railway communications through long lines of tunnels, like the St. Gothard and Mont Cenis, to the above sea, and another is contemplated through the Splügen, which, when completed, the German, Holland and Austrian States will surely resort to the Mediterranean ports for their eastern commerce, and thus the distribution of that commerce, one great source of British wealth, will pass away from her merchants for ever. Indeed, whatever may be the social and political result of the recent Berlin Treaty, it is quite clear that all nations bordering the Mediterranean will draw their supplies of eastern productions directly through the Suez Canal.

That a foresight of these results caused the opposition of Lord Palmerston and British merchants to the construction of the Suez Canal is more than probable; but the man of the occasion, Lesseps, was too strong for them. The idea had grown upon the public mind, and the time had come when the means were within the grasp of an enthusiastic and powerful man, and collecting all his combined resources, the canal is a fact. It has existed long enough to prove that it will be permanent, and its utility has increased to such a degree that its success financially can no longer be questioned by even the most skeptical. British vessels are by far the most numerous which pass through it as yet, and from this it might be presumed that the dangers to English interests, to which allusion has been made, are fallacious; but the bulk of the cargoes does not go to England, although the ships are British. From the supremacy of their naval architects the furnishing of ships will long remain in British hands, but in time ships will follow their cargoes, and another element of wealth will pass away.

That there is ground for these considerations can be verified by reference to the condition of British eastern commerce for the last four years. It is true other causes may have operated to injure it; but the facts are prominent and palpable, that as the consumers are on the direct route of transport, it is folly to expect that time and economy should both be sacrificed by carrying commerce past the points of ultimate destination for distribution, no matter under what flag the transport be made.

CANAL BETWEEN THE ATLANTIC AND PACIFIC OCEANS.

There is, however, another project for an interoceanic canal which has long attracted the serious attention of capitalists and statesmen, both in this country and Europe. The importance and necessity of connecting the Atlantic and Pacific Oceans has been seen and felt ever since America was discovered, and though the project has slumbered from time to time, and been neglected for various causes, it has always commanded consideration. The success of the Suez Canal, and its effect upon the world's commerce, bring the necessity for its construction still more prominently forward, and it now appeals more strongly to the attention of mankind than before. A ship canal, *without locks*, through the American isthmus, has been the dream and hope of many great and enterprising men. Many plans have been proposed for its accomplishment, but the natural difficulties to be overcome have hitherto been considered almost insurmountable—quite sufficient to appal the stoutest heart and shake the strongest nerves. So were they considered in regard to the Suez Canal; but the time arrived when they were all overcome by engineering skill, and it would be well to inquire, speedily and sincerely, whether it has not come to attack and subdue them in opening a ship canal through the American isthmus, as no intelligent person can fail to see that the execution of such a work would place the United States geographically in the center of the trade of the world, and renew commerce on the grandest scale ever conceived by most sanguine far-seeing man.

The various surveys and reconnoissances which have been made along the isthmus between the North and South American continents, indicate several points where water communications can be established. The limits of this latter, however, will only permit reference to the prominent features of each. Several can be dismissed in a few words as disadvantageous. I do not propose to use the word impracticable with reference to any scheme having for its object a work of such vast importance.

The most northerly route, by the Isthmus of Tehuantepec, is long, requires a vast deal of cutting, more than one hundred locks, some tunneling, has no good harbors at its termini, and the consideration of it may be set aside at once.

THE VARIOUS ROUTES.

Great attention has been paid to the Nicaragua route, and it has been most thoroughly surveyed. It is recommended as feasible by high naval and military authorities of the United States. But it has no good harbors, is long, requires from twenty to twenty-four locks, so liable to get out of order in wet climates and slack water navigation, and its termini are especially disadvantageous. Besides it is possible that the increased drainage caused by straightening and deepening the San Juan river, in addition to the drainage opened on the Pacific side, with the enormous evaporation of the climate, might alter the depth of Nicaragua, by no means the deepest of lakes, so as to interfere with navigation.

The line through Costa Rica has good harbors, but has length and declivity against it.

Along the isthmus proper, north of the Gulf of Darien, are found by far the shortest routes of all, and through this part of the isthmus the canal will doubtless be eventually cut, as the approaches on either side, for both steam and sailing vessels, are all that could be desired, and their close proximity to the Panama Railroad, for carrying backwards and forwards machinery, tools, labor and supplies, is a great advantage.

Those spoken of, and which have been more or less surveyed, are the Panama, San Blas, and Darien routes. All require considerable length of rock tunneling for a canal without locks, but being, as before mentioned, much the shortest of any proposed, they will prove decidedly the most advantageous in executing the great work, and the less time consumed in passing ships through when done. Reference will be made to them again.

THE ATRATO RIVER ROUTE.

The difficulties of the more northern routes led to the consideration of constructing a ship canal from the Pacific to the Atrato river, which is navigable for large open vessels at least seventy miles above its mouth, where some improvements would be necessary, and *via* that river several fensible ones have been found. More than twenty years ago, I caused explorations to be made by Messrs. John C. Trantiome, Lane, Kermish, and Porter, of nearly the whole country, and at that time my engineers recommended a canal *via* the Atrato and Truando rivers. This route has since been thoroughly surveyed by General N. Michlor, of the United States Engineers, and is feasible for a canal *without locks*, deep and wide enough to pass the largest class of sea-going vessels, during any state of winds or tides, but its disadvantages, like all the routes proposed *via* the Atrato Valley, are their great lengths, heavy rains, dangerous floods, and the soft, marshy character of the country, through which much of it would necessarily pass, making it exceedingly expensive and difficult to construct and maintain heavy work, in such shaky, spongy, and unreliable soil.

In 1870 the United States Government renewed attention to the subject, and ordered Commander T. O. Selfriedge, U. S. N., an excellent officer, to make surveys of several routes, and he reported the Atrato-Napipi route as being in his opinion the most feasible. This is more southerly than the Atrato-Truando route, has much longer river navigation, is encumbered with several locks, also a tunnel, and has to depend on an artificial reservoir and feeders for a supply of water to feed the canal, which might fail during some extremely dry season, and thus stop navigation for the time being. The Truando route is shorter, has less tunneling, is feasible *without locks*, and has an abundant supply of water at all seasons of the year, as will be seen by referring to the various surveys of that line.

Another route *via* the Atrato-Tuyra rivers, has been recently examined by Lieutenant L. N. B. Wyse, of the French Navy. His survey of 1877 shows several serious difficulties; that of 1878 is reported much more favorable, and as soon as his final report is finished and published, we shall then know the real advantages and disadvantages of the route, as Lieutenant Wyse is an able officer, a most reliable and accomplished gentleman, and will clearly make them known. His enterprising spirit and steady perseverance in examining the difficult country between the head waters of the Tuyra-Atrato and Atlantic Ocean, during the last two winters, and thus giving additional and valuable information to geography and the canal question, are worthy of the highest admiration and praise.

To revert to the three short routes across the isthmus, that along the line of the Panama Railroad is the only one which may be said to have been thoroughly surveyed from sea to sea. It is the longest of the three, would require at least twelve locks, and some tunneling, and being located so near the railroad would be of great advantage; but on the Atlantic side it would run through an almost bottomless swamp, which engineering skill could hardly overcome. The harbor of Aspinwall is not sufficiently protected and capacious to accommodate the ever expanding wants of commerce, and at low tide, in the Bay of Panama, ships cannot come within two miles of the shore, and this portion of the isthmus is very hot and unhealthy.

Several partial surveys have been made of the Darien, which for a long time was represented as the best and only route. The gentlemen who most strongly advocated its advantages were Mr. Gisbourne and Doctor Cullen, of England; but surveys, so far as they have gone, show many and various difficulties to be overcome, and since the partial examination by Commander Selfriedge, it has been generally condemned, and the longer routes by the Atrato river preferred.

THE SAN BLAS OR BAYANA ROUTE.

The route from the Bay of San Blas to the Pacific, *via* the Bayana or Chepo river, is the *shortest* of any yet discovered, being but about thirty miles from ocean to ocean. This route has been surveyed sufficiently to form an idea of the work to be done to furnish the commerce of the world with a straight, deep, wide, and especially short passage from sea to sea, without other than ample tidal locks, which would be used only at high tides, and thus cause but little or no delay. These are the great desiderata for the canal, and if they are supplied it is more than probable that this is the point where the isthmus will be severed.

My attention was directed to the San Blas route in 1864, and with the assistance of Mr. Cyrus Butler and Mr. Luke T. Merrill, I organized and sent out an expedition under Mr.

A. McDougal, chief engineer, with instructions to proceed to the mouth of the Bayana river, and ascend it to the head of tide water, in order to determine how far it would be available for the uses of the canal, and from the proper point he was ordered to survey the route directly to the Gulf of San Blas with chain and spirit level, so as to leave no chance for errors in length or altitude. The party commenced its operations, and ascending the Bayana over ten miles, found that river available for canal purposes with, comparatively speaking, an insignificant amount of dredging, the bottom composed of mud and sand and free from rock. Hence their route led them through a flat, healthy, practicable country, and free from swamp and mud for a distance of nine miles. The depth of cutting having increased to 150 ft., as a matter of economy it was thought advisable to recommend a tunnel from that point. The levels were continued over the summit 1,500 ft. high, until they reached a point of slack water on one of the small tidal rivers emptying into the Gulf of San Blas on the Atlantic side of the isthmus. The rise and fall of the tide was but 2 ft., and the gulf could be seen in full view. The necessary length of the tunnel was set down at seven miles, and from thence to the Gulf of San Blas, as near as could be judged, was about five miles over feasible ground for the canal. On this point Mr. McDougal in his report says: "Though to have gone over the ground the entire distance was desirable, it was not absolutely necessary, as we knew the altitude of the point we had reached, and could plainly see the mouth of the Mandingo river, Kelley's Island, a portion of the eastward coast, and also several small islands in the Gulf of San Blas, and we could triangulate at the distance we had reached with sufficient accuracy for the purposes of our survey. As it was decided to proceed no further we crossed the flat lands on the right bank of the river and ascended a hill, from which we proceeded to triangulate to the various points visible in and about the gulf, and by that means determined the distance." The surveyors were unable to finish the last portion of the route, being stopped by the Indians, who would not until recently permit the intrusion of strangers.

When Commander Selfriedge made his partial survey of his route in the spring of 1870, he commenced on the Atlantic side in the Gulf of San Blas, and, pushing a short distance into the interior, he came upon certain points laid down by Mr. McDougal, and thus verified the accuracy of my engineers' survey to that extent. On page 25 of his report to the Honorable Secretary of the Navy, he says "they made an accurate survey with the spirit level to the head waters of the Marmoni," and again on page 29 he says, "the junction of these two rivers differed from Mr. Kelley's only half a mile, serving as an excellent verification of the correctness of that gentleman's engineers." After reaching the summit, or divide, on account of the lateness of the season, and the rainy season having set in, making it exceedingly slow and difficult to advance, and almost impossible to carry forward sufficient supplies, and conceiving the tunnel to be necessarily ten miles long instead of seven, as determined by McDougal, he fell back to the gulf, and returning to the United States without making a thorough and complete survey of the entire route from ocean to ocean, reported against it on account of the length of the tunnel. Now, without wishing to cast any reflections on the integrity of Commander Selfriedge, who is an able and excellent officer, and worthy of special praise for his zeal and enterprise displayed in several ship canal explorations, I must say I believe he has made an error of three miles in the length of the tunnel. My engineers, well supplied with men, money, instruments, native labor, and supplies, were especially instructed to use the spirit level and chain over the entire route, in order to avoid any errors of distance or altitude, and the survey from the Pacific over the divide down to the high tide water of a small river emptying into San Blas Bay, was made during the dry season, when everything was favorable for the prosecution of the work, and as the rise and fall of tides in that locality is but 2 ft., my engineers could not have been but a few miles from the above bay when turned back by the Indians, and the intervening ground must have been level, or the Atlantic tides would not have flown back to the point they reached.

Commander Selfriedge, on the other hand, commenced his survey in the rainy season, when the rains descending in torrents, flooded the country, and made his work exceedingly slow, difficult, embarrassing, and uncertain for taking correct measurements; in fact he says, on page 25 of his report, "the period of rains was at hand when we arrived at San Blas," and on page 26 he says, "the country for a mile and a half was one vast swamp and cane brake, the latter so interlaced with vines, after cutting a wide swath, it had to be jumped to obtain a vista for a level. . . . And cases happened where the party was obliged to pass the night in trees, the water rising so rapidly as to drive them from their beds." And in another place he makes the following remarks: "Rained three hours, but managed to cut 1,000 ft., working till we could no longer see through the sight views. . . . At this time I felt great apprehension lest I should be obliged to relinquish the survey, our provisions were exhausted, and our crews worn out." Besides this, it is quite clear that Selfriedge did not ascend the Atlantic slope of the Cordilleras through the same valley that McDougal descended, hence their differences of opinion in the length of the tunnel; but this is pardonable, as there are several other valleys that debouch into the Gulf of San Blas, and which would be the most suitable for canal purposes, can only be determined after a careful survey of each. It is quite possible a valley may be found extending from San Blas Bay further into the mountains then the one measured by Mr. McDougal, and thus the distance of seven miles tunneling very much shortened. At any rate, in view of the foregoing brief statements, I think it not presumptuous to ask the English and United States Governments to join in making a thorough and exhaustive survey of this the shortest route on the isthmus, before deciding so great a problem as the most feasible line for an interoceanic canal.

The length of the necessary tunnel is accompanied by the shortest of all open cutting, and ten miles of that is provided by the Bayana or Chepo river. The Gulf of San Blas furnishes a magnificent harbor for the Atlantic terminus, and the harbor on the Pacific is the Bay of Panama. Had the survey been made complete from sea to sea we should have something more positive from which to form a judgment upon the only point where the McDougal report is questioned, that is the length of the tunnel required. We may confidently say, however, that McDougal is not far wrong, as Selfriedge did not go on the Pacific side of the Cordilleras down to the base at all, and consequently his opinion cannot be generally received as conclusive.

But nevertheless it is safe to conclude from the data in our possession that the San Blas route is the shortest of any proposed, will give free and direct communication on one level between the oceans, with only a tidal lock to regulate the currents. The tides in the Pacific rise from 12 ft. to 18 ft., while on the Atlantic side the rise and fall is but 2 ft., hence the apparent necessity of a lock to control the flow of water. Ten miles of the canal is nearly provided for by the river, leaving, according to Selfriedge, ten miles of tunneling and ten miles of cutting, or according to McDougal, seven miles of tunnel and thirteen miles of open cutting, which is generally of easy depth, and through practicable soil and rock, not subject to overflows during the rainy seasons, especially on the Pacific side, where the cutting is the longest. The tunnel is the great and expensive feature of the work, and if that were provided for the rest would be easily accomplished.

The sectional area of a tunnel 75 ft. wide at the bottom, 100 ft. at the water line, with a depth of 25 ft., 40 ft. perpendicular rise, and an arch of 50 ft. radius, giving 115 ft. from the bottom of the canal, and 90 ft. from the water to the crown of the arch, would contain about 1,000 square yards. If the tunnel is to be ten miles in length, 17,600,000 cubic yards of rock must be removed. If only seven miles in length, according to McDougal, the quantity requiring removal would be 12,230,000 cubic yards, and the cost at, say 5 dols., or 1*l.* sterling, per cubic yard would be in the first instance about 88,000,000 dols., or, say, 17,600,000*l.* In the latter it would be about 61,150,000 dols., or 12,230,000*l.* The time required for the work, judging from the progress in making the St. Gothard, Sutro, and other tunnels, would be about ten years in the former, and seven years in the latter event. This estimate is believed to be ample, both in time and money, as improvements in perforating rock are being continually made, both in this country and Europe, from year to year. Engineers and mechanics are giving every attention to the subject of driving tunnels with the greatest possible reduction of time and money, and it is reported a machine has been invented in England which can drive a heading at the rate of from 1 ft. to 2 ft. per hour, or from 8 yards to 16 yards per day. It is easily manipulated, the cost is reasonable, and it is driven by either water or steam power, or compressed air. By the use of this instrument the perforating of the heading of ten miles could be accomplished, working at both ends of the tunnel, in eight years, and seven miles could be driven in six years, making due allowance for delays, mishaps, and such additional time as might be necessary for completing the breakdown, and as the work progressed and got systematized, doubtless the above time would be reduced very materially. Moreover there are other inventions and appliances for driving tunnels, more or less successful, whose inventors and manufacturers are continually striving to improve, and when the great work is commenced, such endeavors will be more strenuous, and we shall not be confined to the use or choice of one method, but will probably have several from which to select.

ESTIMATED COSTS FOR THE WORKS.

With regard to the estimates for the cost of the tunnel, it may be remarked that 5 dols., or 1*l.* sterling, per cubic yard pays for small tunnels of great length, where the difference between the sectional area of the heading and of the complete tunnel is much less than in this case. The heading is the greatest item of expense. In the Mont Cenis tunnel it cost 60*l.* per meter forward. This has been cut down in the St. Gothard nearly one-half, and is fixed at 32*l.*, the average being made up in the comparative cheap cost of the breakdown. With a tunnel having a sectional area of the magnificent proportions herein contemplated, the greater part of the work would be simple quarrying, and it is quite probable the estimated cost of the tunnel would be very much reduced. The expenses of the exterior work will be very much less. To get an idea of its amount, we will suppose the cutting to be through solid rock the entire distance, and of an average depth of 60 ft., as the profile of the route shows this to be ample. Such a cutting, 100 ft. wide, would have a sectional area of 6,600 ft., or about 666 square yards. At 1.75 dols., or 7*s.* (English money), per cubic yard it would cost about 1,165 dols., or 233*l.* per yard forward for ten miles; this would be about 20,500,000 dols., or 4,100,000*l.*, and for thirteen miles it would be about 26,400,000 dols., or 5,280,000*l.* So taking the tunnel according to Selfriedge's opinion, the cost of the canal complete from ocean to ocean would be about 108,500,000 dols., or 21,800,000*l.* If we take McDougal's survey (which I claim is the correct one), the cost would be about 87,550,000 dols., or 17,510,000*l.* Lieutenant Eastman and Mr. McDougal found a channel on the bar at the mouth of the Bayana or Chepo river at low water, of 16 ft., and of sufficient width for all practicable purposes, and this depth was carried all the way up the river with soft, muddy bottom. The mean rise of the tides at this point is 16 ft., so that what work has to be done in the river is quite practicable and inexpensive.

With the large estimates which have been suggested, the expenses of the whole work can hardly exceed 108,500,000 dols., or 21,800,000*l.*; but it may reasonably be hoped it will not be more than 87,550,000 dols., or 17,510,000*l.* The question is whether Selfriedge's opinion of the length of the tunnel required, or McDougal's survey, is the most accurate and reliable. The larger figures as well as the lesser have been given, so that the greatest difficulties can be considered. From what has been said it may be believed that, looking at the subject from its most unfavorable point of view, and from what we positively know already, an expenditure of about 108,000,000 dols., and less than ten years' time, would break down the stupendous barrier of the Cordilleras and relieve the commerce of the world. The probabilities of reducing the cost and time have been alluded to. More extended and exhaustive surveys of the route will more than probably show a much shorter and easier pass through the mountains, and thus reduce the cost considerably below 100,000,000 dols., or 20,000,000*l.*

Great Britain has a large commercial interest in the construction of a ship canal through the American isthmus. The Suez Canal will always be a subject of more or less controversy, as different nationalities with different interests center in and around it on every side, and to protect its safety and neutrality she will have to watch with jealous care day and night continually. There was a time when all Europe combined against British interests and commerce, not only by ordinary peaceful rivalry of trade, but by force of arms, and it requires but little stretch of the imagination to foresee such another or a similar combination. Should such a contingency arise, and the Suez Canal become a bone of contention, England may be obliged to fall back for communication with her Indian Empire and the East to the long and tedious track around the capes, which in these fast moving times would be disastrous. This necessity would not exist were the San Blas Canal opened and free to commerce, as she then would have another line of communication to the East quite as convenient, if not so speedy. Her trade by the Suez Canal might be shut up, and her commerce or convenience would hardly suffer, or, if absolutely necessary, she might close it herself, either in the Mediterranean or at Aden, and still have every facility for commerce and transit to the East which the Suez Canal gives to her, while other European nations would be comparatively cut off. Moreover, for the guardianship of the neutrality of the American Isthmus Canal she could count upon the active and friendly alliance of the United States; indeed, this to a great extent is provided for already in the Clayton-Bulwer Treaty. For such a purpose the United States would readily unite with England, and those two nations allied in maritime affairs could bid defiance to the rest of the world.

The advantages of the canal would be largely and immediately reaped by Great Britain. In 1870 her tonnage with the west coast of North and South America, the Pacific Islands, and Australia, amounted to a little below two millions of tons, all of which would inevitably pass the canal. The saving in time and proportionate expense on all this by using the canal would be measured by weeks and months. Moreover, it must be remembered that from all parts of China, Japan, and Australia, east of Singapore, the distance to England would in no case be much greater than from those ports *via* the Suez Canal. The navigation of the Red Sea is almost necessarily confined to steamers. But no intricate navigation is encountered by the American Isthmus Canal, as by far the greater distance is over the open ocean and in favorable latitudes, and the sailing tonnage of England to such ports would doubtless follow this route and add immensely to the aggregate of commerce. The saving in time would in no small degree restore the equilibrium between time and expense, which has been seriously disturbed by the Suez Canal, and eastern cargoes in sailing ships would go in bulk to England to be distributed through her hands. At present the economy in time by steamers through the Red Sea and Suez Canal is rapidly overcoming the economy in money by sailing vessels *via* the capes, and the latter are being driven from the trade.

The United States appears next in the list of nations which would use the canal. In 1870 her tonnage engaged in commerce with the West Coast and other countries in the Pacific, which would necessarily pass through the canal, amounted to about one million tons. It is continually increasing. France and Germany employed in the same year, respectively, 170,000 and 146,000 tons in the same trade, which would certainly take this route; and between the United States, England, Europe, China, and other eastern countries, it is safe to say we have an aggregate of 4,000,000 tons of commerce that would seek a passage through the canal. For the purpose of this article it is needless to enter into details showing the value of this commerce. A simple glance at the map will most clearly impress us in every case of the enormous economies of distances, time, money in cost of freight, labor, insurance, wear, tear, and various other items of commercial expense, and the canal would pay a corresponding toll. Without doubt it would be self-supporting soon after completion, and finally pay largely, as but little would be required to keep it in repair.

To provide the necessary capital and the interest thereon during construction, various plans have been suggested; but I think the best would be to issue the stock of the company for cash from time to time as required, and that the various governments interested should pay the interest on the amount so issued during the construction of the work only. By that means a ready market for the subscription and sale of the stock would be found in this country or Europe, and the amount of money advanced by the governments could be paid either by creating for the purpose a sinking fund, or mortgaging the property.

What is especially wanted now is a joint survey made by the English and United States Governments, of this *much the shortest route of any on the isthmus*, in order by that able, powerful, and thorough means, all the possible advantages and disadvantages may be made known plainly to the commonest understanding. Then, and then only, shall we fully comprehend the task before us in executing the work. Notwithstanding all that has been done by my engineers and Commander Selfriedge, the examinations thus far amounted to only a reconnoissance. The examinations should be made in full force, thorough and complete in every particular from sea to sea, and the parties should be well supplied with instruments and food, to remain on the ground long enough to procure every possible important information relating to the feasibility of the route. Although the dense growth of underbrush and trees exists almost everywhere in the tropics to delay, bewilder, and mislead the best surveyors, it is possible and feasible by means of temporary towers or tied fast balloons, to ascend high enough to get a good view of the country, and thus determine at a glance the depressions in the mountains, and the general direction the line of survey should pursue to encounter the least possible obstacles. The officers in command should be especially selected and the work continued until every foot of the locality has been examined and every feature of the route developed.

It is to be hoped that the project which has commanded the serious attention of leading men in both hemispheres may no longer be delayed, and that the grandest enterprise of this age of marvels may soon be commenced is the earnest wish of yours, very truly.

FREDERICK M. KELLEY.

New York.

THE OHIO RIVER COAL BARGE SYSTEM.

ONE of the leading features of the Ohio Valley which most favorably recommends it to manufacturers and others, is the uniformly low rates for good coal from Pittsburg and other points, and for the information of those interested, we have been at pains to collect from the proper sources the following facts regarding the extent and character of the Pittsburg coal trade:

In Pittsburg and vicinity there are 50 "operators" or firms engaged in the coal business, about one-half of whom sell at the mines, the other half are "shippers" engaged in running coal to southern ports. The shipments for southern consumption from Pittsburg amount annually, on an average, to 80,000,000 bushels of coal and 20,000,000 of coke, which is sent south by the shippers on the tides as they occur. For this purpose they employ 96 tugs or tow boats and about 1,500 barges and "shells" in which the coal is transported. Each barge costs about $1,000 and carries from 12,000 to 13,000 bushels. The shells cost about $500, and they carry about 24,000 bushels. The barges, when unloaded at their destination, are returned to the mines; the shells are generally sold in the South and broken up for other uses by the purchasers.

On an average there are ten coal tides or "rises" at Pittsburg during the year, which occur suddenly, and frequently last only from twenty-four to thirty-six hours. The barges and shells must therefore be kept loaded and ready

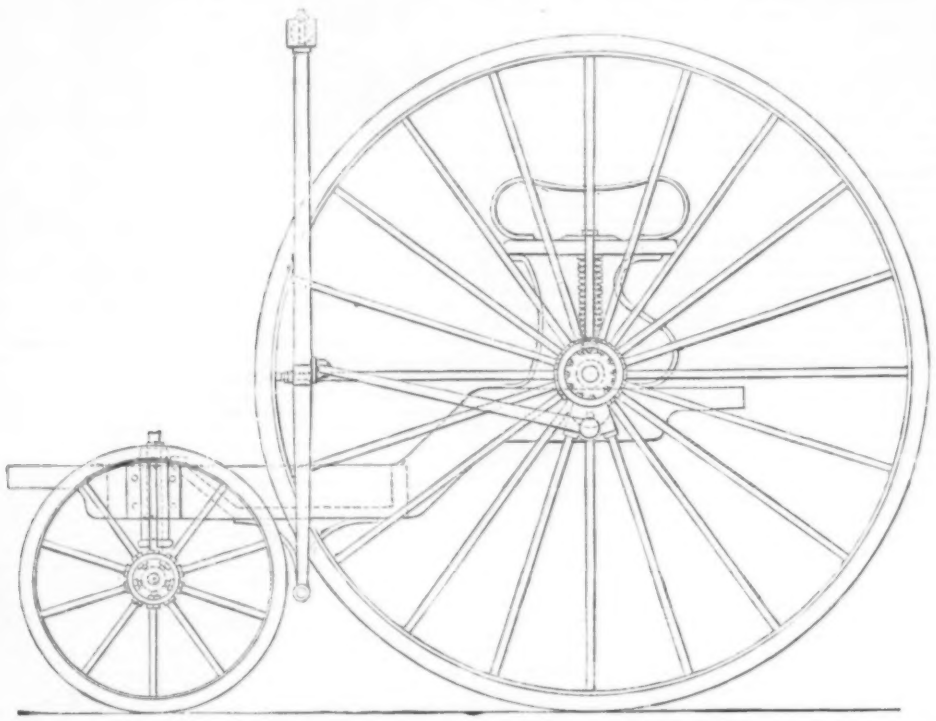
for departure at an hour's notice. When the opportunity arrives the tows are lashed to the tugs, each taking about ten barges, containing, say, 150,000 bushels of coal, the great length of the tows, and the short time allowed by the rapidly falling river requiring the most expeditious movements.

By this admirable barge system coal is kept at a price but little above that of Pittsburg to the cities above the falls of the Ohio, the expenses of running the coal to Louisville, including the cost of returning the barges to the mines, being only about one and a half cents per bushel.

Thus is accounted for the usual low price of Pittsburg coal at Louisville, the average for the past five years being only 6½ cents per bushel. It is true that the development of and the large and increasing production of the Kentucky coal mines check speculative prices and coal famines, but the barge system enables us to procure Pittsburg coal at low rates, and on the other hand this supply keeps the Kentucky coal men in check, as is shown by the following statement: Since the 1st of December last—three months—the receipts from Pittsburg at Louisville have been only 30 barges, and the price to-day is but 7 cents per bushel.—*Louisville Manufacturer.*

ROMANS' HAND CAR.

THIS vehicle was designed for the Philadelphia and Reading in 1848, by Samuel Romans, who is now living in Columbus, O. The machines were built at the Pottstown shops, and have been used ever since by track bosses. They have 48-in. drivers, 18-in. truck-wheels, and weigh 360 lb.; will carry three persons, and can make 8 miles an hour without much exertion. The lever fulcrums at one end; the quadricycle fulcrums in the center. The spokes of the wheels are made of iron pipe.—*Railroad Gazette.*



ROMANS' HAND CAR USED ON PHILADELPHIA & READING RAILROAD.

IRON AND STEEL AT PARIS.

MR. D. J. MORRELL, of Pennsylvania, Assistant Commissioner to the Paris Exhibition, has submitted his report to the Secretary of State on the exhibits of iron and steel in that Exhibition.

The leading iron and steel producing countries of the world, in the order of their importance, are enumerated as follows: Great Britain, United States, Germany, France, Belgium, Austria and Hungary, Russia, and Sweden. These countries produce 98½ per cent. of the world's annual product of iron and steel; and all were represented at the Paris Exhibition except Germany.

Speaking of the French exhibit Mr. Morrell says that the progress made by that nation in the manufacture of rude castings, bar iron, iron and steel rails, and some other heavy products, has been known to the world since the Paris Exhibition of 1867, but that in 1878 showed more advancement in the manufacture in the finer forms of iron and steel and many of the products derived from them. Among the exhibits are mentioned an 80-ton steam hammer—the largest in the world—and an armor plate, 13 ft. 10 in. long, 8 ft. 6 in. wide, and 2 ft. 7 in. thick, weighing 65 metrical tons. A cast steel shaft was also exhibited, 64 ft. 4 in. long and 17 in. in diameter, and weighing 20 tons. The exhibit of Great Britain, Mr. Morrell says, was not worthy of the position she occupies in the production of iron and steel. One firm sent to the Exhibition rails 130 ft. long, rolled direct from the ingot and bent into four lengths of 32 ft. each. Some interesting specimens of iron used in ordnance were also shown, and a forged hollow shaft, 33 ft. 7 in. long, and 17½ in. in diameter, was also exhibited.

The English showed very numerous and excellent specimens of agricultural machinery and cutlery.

Germany was not represented in the Exhibition, but Mr. Morrell visited that country for the purpose of making a careful inspection of the iron and steel industries, and in order to make the report a complete one. The most interesting feature of his paper in relation to Germany is that which treats of the competition between the three great iron and steel producing countries of Europe. Since Germany acquired the iron districts of Alsace and Lorraine she has become a troublesome rival for France, while the British manufacturers are sending their products to Germany itself, and competing with articles of iron and steel manufactured at home. Mr. Morrell calls attention to the advantages which the United States possesses in being so widely separated from European countries, and thus being relieved to a great extent from competition that would otherwise exist.

Mr. Morrell's report in regard to the iron and steel industries of Belgium is very interesting. He says there is something amazing in the comparative prosperity of the Belgian iron and steel industries when their spare natural resources are taken into consideration, and when the same industries of more favored countries are experiencing a greater or less depression. The causes for this condition of things, Mr. Morrell says, are to be found in cheap labor, long hours, the technical education of workingmen, strict economy in administration, attention to minutest details, and use of the most improved labor-saving machinery. The population of Belgium is very dense, 5,000,000 people inhabiting 12,000 square miles of territory. The country is a hive of industry. There is no room for drones. Every man has his work to do, and he must be content with small wages, for high wages would soon put an end to all employment by destroying the ability of Belgium to compete in foreign markets. Strikes are exceedingly rare, and when they do occur they are soon terminated, because the government will not tolerate them. Personal economy is essential to existence. The labor of women and children is utilized. Railroads through its own territory, favorably situated seaports, and a trading spirit handed down from the middle ages, aid in securing foreign purchasers for Belgian manufactures. Belgium utilizes all her resources. She is industrious and frugal. She neglects none of her opportunities. Mr. Morrell concludes this portion of his report by the remark that much of the distress existing in other countries might be obviated by the practice of the same virtues, and that it would not involve the reduction of wages to the Belgian standard.

The Austro-Hungary exhibit of iron and steel was exceptionally fine, and showed remarkable progress. The same may be said of the Russian exhibit, and also of that of Sweden. The progress in the app ication of new methods in the last named country is slow, which, Mr. Morrell says, accounts for the absence of much increase in her products.

The exhibit of the United States was inadequate, and did not fairly represent the industrial resources and progress of the country; the great American rolling mills and steel works literally made no sign of their capacity, nor did other establishments, in the manufacture of iron and steel. Not a rail nor keg of nails, bar of iron, or ingot of steel of American manufacture was on exhibition. A few articles which attracted favorable attention are enumerated.

In his general survey of the features of the Paris Exhibition, as far as they relate to iron and steel, Mr. Morrell says that he is led to the conclusion that they present very little that was new to the practical man who is engaged in the manufacture of these products. There were evidences of progress of the dephosphorization of iron, in the substitution of machine for hand puddling, in the simplification and perfection of the open-hearth process, in the casting of steel, in the manufacture of wrought iron and steel and their application to new uses, but no absolutely new process for the manufacture of iron and steel was exhibited or described. The metallurgical world, he says, has apparently reached a resting place in the matter of invention, and steel makers everywhere seem to have reached the conclusion that in the improvement of present processes, and in the extension of the use of iron and steel, are they to find problems worthy of their attention in the future. The display of iron and steel products at the Paris Exhibition has never been equaled in a world's fair, while the exhibits of machinery have only been surpassed by that made at Philadelphia, which was more extended and more varied than that of Paris, and had the additional advantage of being more generally in motion. At the same time, the Paris Exhibition demonstrated more fully than that of Philadelphia or any previous one, the efficiency of machinery in all industrial enterprises, and exhibited the efforts of every progressive nation to obtain the best machinery, for its own service, and the necessity brought upon all by their active competition to adopt every new device and improvement which tends to increase, perfect, and cheapen products.

STEEL WELDING.

By SERGIUS KERN, M.E., St. Petersburg.

IN some articles inserted in this journal the author stated that pure steel, nearly free from phosphorus and sulphur, and containing 25 to 30 per cent. of carbon, stands easily the process of welding, if, indeed, the work is done with care and by clever workmen.

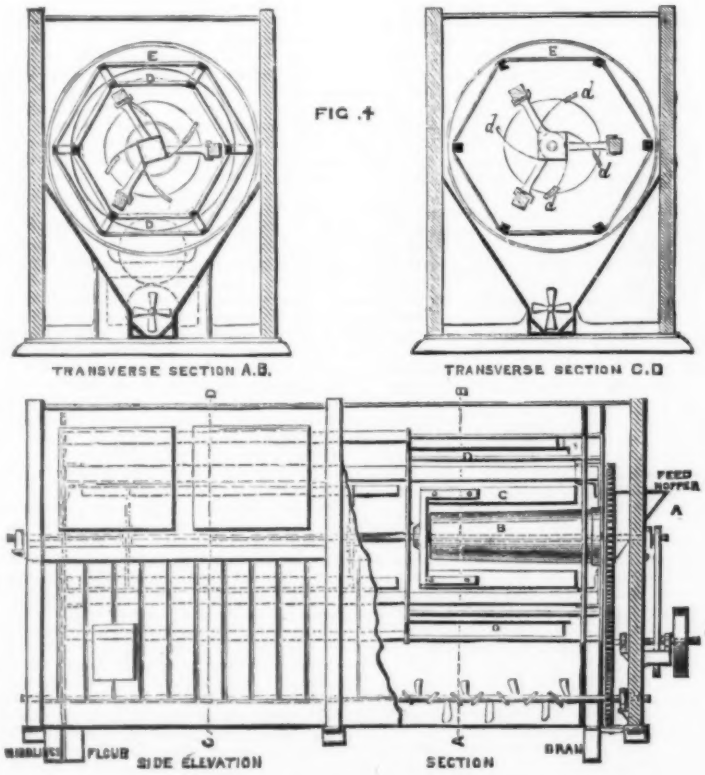
It may be mentioned here that to a steel ship-plate, 2 ft. wide and ⅝ in. thick, a steel plate (2′ × 2′ × ⅝″) was easily welded, and a perfectly clean and good joint was received.

In another case steel strips (6″ × 4″ × ¼″) containing 25 to 26 per cent. of carbon were welded together; very often after cooling the plate was bent double, through the weld, without the least fracture in or near the welded part. In some experiments, such plates were bent at a dark heat, and they often, not always, resisted this severe test, as it is known that at this temperature the steel is more liable to break. These trials show that Russian Bessemer steel is of a very good quality.—*Chem. News.*

MILLING MACHINERY AT THE PARIS EXHIBITION.

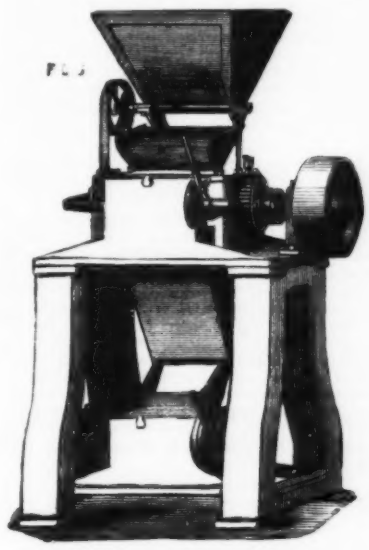
THE "Victor" silk flour dressing machine, exhibited for the first time, is another example of a manufacturer taking advantage of the experiences of foreign millers—unless, indeed, the same idea has been simultaneously hit on by two individuals—by shortening the length of the cylinders. The arrangement of the silks and the adoption of a centrifugal motion enables the constructor to obtain a larger amount of sifting surface with a corresponding decrease of length. The advantages claimed for the design are, in addition to the above named—(1) the aerating property of the distributers; (2) the bran is taken out without passing over the silk, is

FIG. 4



THE VICTOR FLOUR DRESSING MACHINE.

better cleansed and less broken on account of the action on it of the perforated metallic inner reel at the head of the machine; and (3) the protection offered to the silks by the metallic reel, as "it also takes out the husks of oats" (*sic*), and all extraneous substances of equal size with the bran which would otherwise damage them. The con-

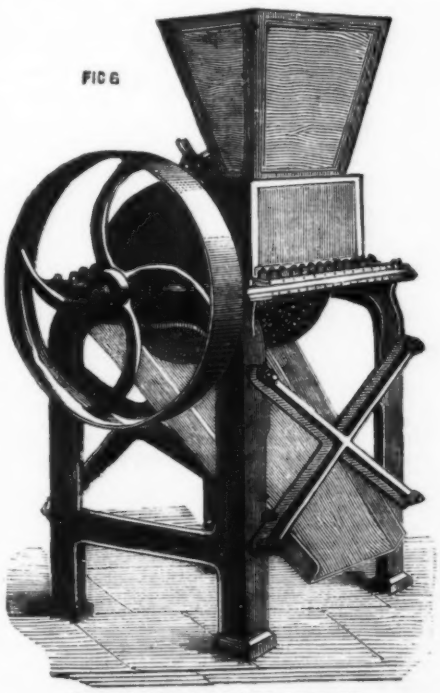


PINI'S GRAIN CUTTER.

struction of the frame and case does not differ much from the ordinary types; the reel is fixed quite level, so that the hoppering beneath it is made very steep, and prevents the flour from hanging up on the sides. The reel is composed of two circular iron plates, one at each end, to which are bolted a pair of three-armed crosses having a short hollow central shaft, on which the reel revolves. A smaller shaft is carried through the hollow ends for the entire length of the machine, to which are fixed the distributers. These are in the form of a slightly curved fan, and are divided into two parts, the one operating on the meal and cleaning the bran at the head of the machine, and the other acting as a distributer to the meal in the second part of the reel.

The reel is also divided into two parts; in the first or head-end part there is an inner and an outer reel, into the first of which the feed is carried rather more than 3 feet by a large tube; here the bran is separated by the perforated metal covering and carried back by diagonal conveyors to the head-end and discharged. The flour and sharps passing through the perforations fall on to a smooth metallic cylinder fixed between the inner and outer reels, and by a simple contrivance are fed on to the silk covering of the outer reel at its head end. Owing to this arrangement the flour, after it has been separated from the bran, passes over the entire length of the silk, so that no space has been lost by the preliminary operations of the internal metal reel. In the second part of the reel the distributers, without having any violent action, throw the meal in a regular cloud equally against the whole interior surface of the silk, whereby, in addition to the increased capacity of the latter, the meal is aerated, the dressing more perfect, and the quality of the flour improved.

In the accompanying sketch, Fig. 4, A is the hopper, B feed tube, C perforated metallic reel, *d* the distributers,



WILLHELM'S GRAIN CUTTER.

D D the smooth metallic cylinder, E the silk. The contents of the stand were completed by other milling appliances, millstones and a steam wheat damping apparatus, which is evidently a step in the right direction, as the amount of moisture communicated to the grain is equal throughout, and as the apparatus is apparently to be used in immediate conjunction, the mills cannot have sufficient time to penetrate far enough beyond the husk to injure the kernel, and necessitate the expensive process of drying the flour, as is so often the case where hand damping is resorted to, on account of unequal humidity and penetration consequent on irregular distribution and imperfect turning over.

GRAIN CUTTERS.

We illustrate Pini's grain cutter and Willhelm's grain cutter, new auxiliaries to the process of high grinding, specially intended to render the application of the system to the softer kinds of grain of England, North Germany, and France. Fig. 5 shows the general arrangement of Herr Pini's machine, the inventor of the disk roller mills. It will easily be understood that the grain descending from the hopper falls on to a wire frame constructed in such a manner that each grain falls in the direction of its length at right angles to the edges of the threaded cutter rollers, so that it is divided into two or three pieces of equal, or nearly equal lengths, without any of its particles being reduced to flour. Unfortunately, owing to the supineness of the inventor, we are not able to give practical data of its capacity, but from the specimens we examined during the different stages of its first construction and improvements, we were perfectly satisfied that it would supply a much wanted adjunct to the preliminary operation of grinding with grain too soft and yielding to enable it to compete on an equal footing with harder and more brittle corn on chilled rollers, smooth or ribbed. The second machine, of which also we have already spoken, is shown in Fig. 6. The principle of construction is very simple and easily understood. The grain falls from the hopper on to a set of steel knives placed in the shape of a gridiron, between whose bars the perforated steel disks revolve at great speed. The machine has several apparent advantages over the Pini system, inasmuch as there are no adjustable parts excepting the feed; the knives can always be reset with very little trouble, and the grain is never subjected, even by chance, to any other than a direct cutting force, whereas with rollers there is always a probability, however well the cutter edges may be set and adjusted, of a fortuitous squeeze, innocuous possibly on a large quantity of grain, but, nevertheless, the one particular motion which the inventor has tried to avoid. The upper edges of the knives are beveled, as seen below: so that each pair act as a sort of supplementary hopper or guide toward the perforation in the disks. In all other machines of this kind rollers in some form or another have been adopted as the first principle, and if for nothing else, great credit is due to Herr Peregrin Willhelm, of Paden, near Vienna, for the originality of his idea, and his entire departure from the beaten track of his predecessors. The machine exhibited is No. 2, with twelve disks, and is calculated to "schrott" or break 18¾ tons of grain in twenty-four hours, and requires somewhat less than one horse power to drive it. Although specially designed for soft wheat, the trials made with hard Hungarian corn gave a very satisfactory result as compared with the usual first operations of "schrotting" with roller mills. In fact, much as we are impressed with the advan-

tages of most of the systems of roller mills over the old French stone, as regards the power required, etc., etc., the utter inability to eliminate the "squeezing" propensity, either in the disk rollers or by any introduction of a differential motion in speed, has hitherto prevented millers from obtaining a sharper-edged "schrott" than was formerly produced by a careful arrangement of the stones, although the cost has been considerably reduced; and we firmly believe that this great desideratum—a sharp "schrott" free from flour—will be more readily obtained, whether the grain be soft or hard, by the use of cutters as a preliminary operation, and a better final product, than can ever be expected from the most elaborate combination of decorticators and disintegrators with either rollers or stones, and that the introduction of this or some other similarly operating machine will reduce the somewhat complicated operations of high milling to a simplicity equaling, if not surpassing, that of the so-called German or low-grinding system, and tend to overcome, by a convincing proof of its superiority and applicability to grain of every sort, the conservative principles which have hitherto stood in the way of fair trial and general adoption in this country. It is needless to urge the want of public taste for better flour, or the disproportion of resultant returns to current expense. The miller in his own self-interest must see and acknowledge that superior wares will command a higher remuneration, as witnessed by the high price paid for Hungarian flour, and a sale will always be found for the poorer numbers, which in quality would not be inferior to the products of the present system; and although we are ready to admit that a few spirited trials have not met with the success they deserved, we believe that the cause of failure is in no way attributable to the system, but rather to the lack of adaptation to every quality of wheat, to the absence of auxiliary machines to overcome mechanical difficulties, to an erroneous interpretation of the principles involved, and to a pardonable prejudice against an innovation whose practically successful results are too distant to enable the bulk of those more interested to satisfy themselves by personal observation of the immense advantages offered by adopting the system employed by Hungarian millers.

SILK CULTURE IN THE UNITED STATES.

UNDER the direction of Mr. Le Duc, Commissioner of Agriculture, Prof. C. V. Riley has caused a manual to be prepared on the above subject, from which we make extracts as follows:

Without going into details as to the history of past attempts at silk culture in North America, it must be obvious to all who thoroughly investigate them that the causes of failure have ever been transient ones. They may be summed up in the statements that (1) labor has found more profitable avenues of employment, and (2) that there has been no home market for the cocoons. At the present time, the first statement no longer has force, but the second holds as true now as it ever did.

As a means of meeting the difficulty, I have urged, and would urge, that Congress give to this department the means to purchase, erect, and appoint with skilled hands, on the department grounds, a small filature or reeling establishment. In such an establishment reelers could be trained, and the cocoons, at first raised from eggs distributed by the department, could be skillfully reeled and disposed of to our manufacturers. A market would thus be formed for the cocoons raised in different parts of the country, and a guarantee be given to those who choose to embark in silk culture that their time would not be thrown away. All industries should be encouraged in their infancy; and for the first few years, or until the silk industry could be considered well established, the cocoons should be paid for at the European market rate, plus the cost of reeling, which would range from 50 cents to 75 cents per pound of choked cocoons. This last should be looked upon as a premium offered by the government to the raisers, in order to stimulate the industry until such time as the reeling might be safely left to private enterprise, when government encouragement could be withdrawn.

Meanwhile, and pending Congressional aid, those who desire to raise silk worms in this country, for profit, have three alternatives; either (1) to ship the choked cocoons to Europe, (2) to reel them, or (3) to raise eggs and sell these.

(1) That the children and more feeble persons in a household may find profitable employment in raising cocoons to be shipped abroad is proven by the case of Mr. E. Fasnach, of Raleigh, N. C., who has for several years been in the habit of thus shipping the cocoons reared by his family. He sends in bales 6 by 5 feet in size, and averaging about 40 pounds of stifled cocoons, for which he has obtained as high as $2.50 per pound net, the freight costing only $8 per hundred pounds between Raleigh and Marseilles. Mr. B. A. Weber, of Rockford, Ill., last year raised 40 pounds of cocoons, and also shipped to Europe through New York brokers, and others have done likewise; but I would advise no one to invest capital on this basis.

(2) Nor would it be safe for individuals to rely on reeling their own silk. The art of reeling in modern filatures and with steam appliances has been brought to such perfection that the hand reeler cannot hope to produce a first-class article. The only way in which silk reeling can be managed profitably, at present, is where a colony of silk raisers combine to put up and operate a common filature, as in the case of the settlement at Silkville, Kans., the colony of French and Italians who located at Fayetteville, N. C., in 1876, or the Italian settlement at Vineland, N. J.

(3) Under existing circumstances, more money has been made by the sale of eggs than by either of the other means, and silkworm growers in this country have gradually drifted into this branch of the industry. Eggs raised in this country are free from disease, and the fact that as high as $6 and $8 per ounce have been paid for them, and that France paid in 1876, 114,000 francs and in 1877, 1,691,400 francs for eggs exported from the United States,* is as eloquent in showing the remarkable adaptation of our country to silk culture as that other fact, not generally known, that the chief of the French commission to our Centennial confessed that there was no silk in France superior to some that was there on exhibition and grown in North Carolina. The production of a certain number of eggs does not necessarily prevent the production at the same time of choked cocoons or reeled silk; and the pierced cocoons that have been used for breeding purposes have also a certain market value, commanding about $1 per pound at Paterson, N. J. This egg producing branch of the industry can, however, only admit of a limited expansion.

As a means of indicating the profits in silk culture I have prepared the subsidiary estimates. Optimistic theorists have done much harm in the past by making fabulous calculations as to the profits of silk culture. The figures here given are based on data furnished by men like Messrs. E. V. Boissière and L. S. Crozier, of Silkville, Kans., E. Fasnach, of Raleigh, N. C., T. N. Dale, of Paterson, N. J., etc., and on the current prices as quoted in the *Moniteur des Soies*. They are in every sense moderate estimates, but it must not be forgotten that they do not include capital invested in the shape of food plants. As yet, and until Congress gives the necessary encouragement, it were safest for those only to embark in this culture who already have mulberry trees to use or who decide to feed Osage orange.

PROFITS OF PRODUCING COCOONS: ESTIMATES FOR TWO ADULTS, OR MAN AND WIFE.

Average number of eggs per ounce, 40,000.

Average number of fresh cocoons per pound, 300.

Average reduction in weight for choked cocoons, 66 per cent.

Maximum amount of fresh cocoons from one ounce of eggs, 130 to 140 pounds.

Allowing for deaths in rearing—26 per cent. being a large estimate—we thus get, as the product of an ounce of eggs, 100 pounds of fresh or 33 pounds of choked cocoons.

Two adults can take charge of the issue of from 3 to 5, say 4 ounces of eggs, which will produce 400 pounds of fresh or 133 pounds of choked cocoons.

Price per pound of fresh cocoons (1878), 50 cents.

Four hundred pounds of fresh cocoons, at 50 cents, $200.

Price per pound of fresh cocoons (1876), 70 cents.

Four hundred pounds of fresh cocoons, at 70 cents, $280.

Actual sales in Marseilles, December, 1878, of choked cocoons, 15 francs per kilogramme, or $1.66 per pound, which for 133 pounds of choked cocoons would be $220.78.

Price per pound of choked cocoons (1876), $2.25; 133 pounds of choked cocoons at $2.25, $299.25.

Freight, packing, commissions, and other incidental expenses, say $25, making as the return for the labor of two persons for six weeks, at the present low prices, $195.78.

Calculating on the basis of $1.50 per pound of choked cocoons, which, as shown in the following estimates, a reeling establishment in this country could afford to pay, we get approximately the same amount, viz., $199.50. As already stated the capital invested in food for the worms is not included in these estimates, nor is the first cost of the ounce of eggs deducted. The silk grower should raise his own "seed," and the time required for this purpose is more than compensated for by the time saved in feeding during the first and second ages of the worms, when the whole time of two adults is not required as it is subsequently.

APPROXIMATE PROFITS OF REELING.

One pound of reeled silk requires 3⅗ pounds of choked cocoons.

An expert can in six days reel 4½ pounds of raw silk.

Price of best raw silk in French market, 1878 (market very low), $8.50 per pound.

Nine pounds of raw silk, at $8.50, $76.50.

The discount for cash, commissions for selling, and transportation would reduce this to $65.42.

To produce 9 pounds of raw silk would require the labor of two reelers for six days, at $1 per day, or $12; adding to this $2.50 for indirect labor, we get $14.50 as the cost of labor in reeling 9 pounds.

* These figures are on the authority of the *Moniteur des Soies* for January 8, 1879, but they include also those received from China through the United States.

Thus the labor to reel 1 pound of raw silk will cost $1.70, or that to reel 1 pound of choked cocoons, approximately, 50 cents.

Deducting the cost of reeling from the $65.42 obtained, we have $50.92 with which to buy the necessary cocoons; say 33 pounds of choked cocoons for the nine pounds reeled silk. If we use $49.50 of this sum for this purpose it will enable us to pay $1.50 per pound for our cocoons, and we still have $1.42 as a profit on every 9 pounds of raw silk manufactured. This, if we employed two hundred reelers, would be a yearly income of $7,384.

It is safe to say that the process of reeling just about doubles the value of the product, and if the silk-raiser can reel his own cocoons he may safely count on this increase of its value, provided it is well reeled.

What the actual profits are that accrue to the owners of the large filatures in Tarascon, and other parts of South France or Italy, it would be impossible to state without having access to the books of the companies.

ESTIMATE OF PROFITS IN RAISING EGGS.

Average number of eggs in an ounce, 40,000.

Maximum number of cocoons from one ounce of eggs, 40,000.

One-half of these, or 20,000, are females.

Number of eggs laid by each female, say, 300.

Quantity of eggs from one ounce, 6,000,000, or 150 ounces.

Deducting, as probable loss from all causes combined, one-half, we have 75 ounces.

Price of eggs in Europe, $2 to $5, say $3 per ounce.

Amount realized on 1 ounce, $225.

On the basis of the first estimates two adults could take charge of the issue from 4 ounces of eggs. These would yield the sum of $900, and, even after allowing for the first cost of eggs, trays, commission, freight (which is light), extra time and labor (say another month), and incidental expenses, it leaves a very excellent return.

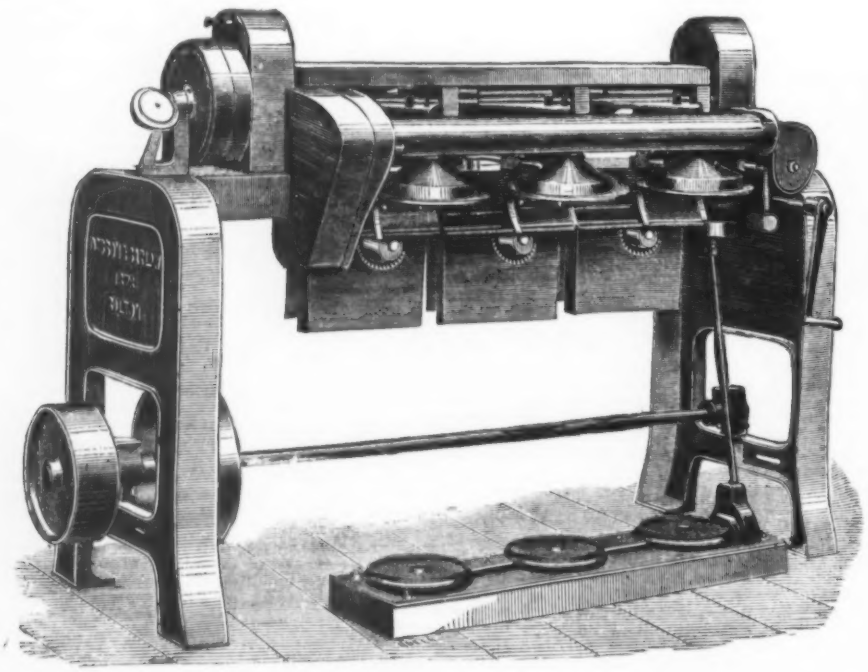
In studying the above estimates the reader must bear in mind that the silk industry, like all industries, will have its ups and downs—its periods of buoyancy and depression. It is just now going through one of these last. Silk-culture never was and never will be an exceedingly profitable business, but it adds vast wealth to the nations engaged in it, for the simple reason that it can be pursued by the humblest and poorest, and requires so little outlay. The question of its establishment in the United States is, as I have elsewhere said, "a question of adding to our own productive resources. There are hundreds of thousands of families in the United States to-day who would be most willing to add a few dollars to their annual income by giving light and easy employment for a few months each year to the more aged, to the young, and especially to the women of the family, who may have no other means of profitably employing their time.

"This holds especially true of the people of the Southern States, most of which are pre-eminently adapted to silk culture. The girls of the farm, who devote a little time each year to the raising of cocoons, may not earn as much as their brothers in the field, but they may earn something, and that something represents an increase of income, because it provides labor to those members of society who at present too often have none that is remunerative. Further, the raising of a few pounds of cocoons each year does not and need not materially interfere with the household and other duties that now engage their time, and it is by each household raising a few pounds of cocoons that silk culture must, in the end, be carried on in this as it has always been in other countries. Large rearing establishments seldom pay."

IMPROVED COTTON STRETCHERS.

MESSRS. DOBSON & BARLOW, of London, exhibited at Paris several improved stretching machines, at the late Paris Exhibition, one of which we illustrate in the accompanying engraving.

It is a stretcher containing three registers, of four rollers each. The several rollers run at different speeds, the one over which the cotton passes last running at the greatest velocity. Hereby the fibers are well stretched.



IMPROVED COTTON STRETCHER.

From these rollers the cotton passes between two cylindrical rods extending through the entire length of the machine and revolving slowly. They are inclosed in a sheet iron cylinder. They deliver the band of cotton into funnel-shaped iron pots, which, when full, are removed and emptied out.

Should the band of cotton fibers be irregular in thickness or tear, the machine stops automatically. Hereby the operator's attention is called to the difficulty, which may now be removed.

CLEAN PHOTO PLATES.

By F. A BRIDGE.

I HAVE adopted the following plan for about seven years, and never spoil a picture through the plate being dirty, although some of my small plates (used for negatives for enlargements) have been used over and over again.

Fill a copper about two-thirds with water, and when it boils, put in a couple of packets of Manby's cleansing crystal; stir well, and while the water is still boiling, drop in your dirty plates, face downward. When the water has cooled sufficiently, take out your plates, and in nine cases out of ten the films will be left behind in the water. Rinse the plates well in clean cold water, and, while still wet, rub them over with Solomon's Diamond Polish (or tripoli and water with a little methylated spirit). I allow this to dry on, and when I require them for use merely rub it off (don't forget the edges) with one leather, and then give a final polish with another; but they may, of course, be cleaned and polished at once if preferred.

I may, perhaps, mention that I never use a substratum for dry plates, but I invariably edge my plates—large and small—with India-rubber in benzole, and I am never troubled with either dirty plates or split films.—*Photographic News*

ON THE REDDENING OF CARBOLIC ACID.

OWING to frequent complaints from purchasers and consumers of carbolic acid, about its acquiring a red color, the firm of Gehe & Co. (of Dresden) have published the following:

Many prominent chemists, and all manufacturers of crystallized carbolic acid, have long endeavored to discover the cause of the reddening of pure crystallized white carbolic acid. But in spite of their careful investigations and experiments, the reason still remains unknown. It is inexplicable why, for instance, a portion of a distillate should remain perfectly white for months, while another portion of the same distillate turns red. Some chemists maintain that this reddening is a characteristic trait of perfectly pure carbolic acid; but this has not been proven. Whatever may be the cause, it is universally conceded that such colored carbolic acid, provided it has the correct boiling point, is precisely as good as the white, and need not be rejected. The Phar. Germ. prescribes that it should melt between 25° and 30° C. (77°—86° F.), but it has generally a high melting point [the U. S. Ph. gives the latter between 93° and 106° F.] No manufacturer can warrant the permanency of the white color of his carbolic acid.

ON ANILINE AND THE METHYLATED TOLUIDINES, AND ON THE DYES DERIVED FROM THEM.

By P. MONNET, F. REVERDIN, and E. NOELTING.

ALL these bases on oxidation yield coloring matters of different shades, and in greater or less quantity.

We have oxidized them by the method generally pursued in the manufacture of methylaniline violet. The base to be acted upon is mixed with ten parts of silicious sand, a concentrated solution of a salt of copper, and a small quantity of acetic acid, and the whole is then left for two or three days in a stove heated to 122° Fahr. (we have made use, in fact, of the stove employed at the works of MM. P. Monnet & Co. for the manufacture of methylaniline violet.)

At the end of this time the mass is found to have grown hard; it is ground to a fine powder, and heated in the water-bath, after having been moistened and mixed with the quantity of sulphuret of sodium necessary to decompose the double salt of copper and of coloring matter; then it is extracted with boiling water, and the coloring matter is precipitated with salt. Extraction with boiling water never suffices for the complete extraction of the sand; we have, therefore, in general, treated the residue with alcohol, in order to try the tinctorial effects of the portion soluble in that liquid. In certain cases, even such as monomethylmetatoluidine and dimethylmetatoluidine, the coloring matter cannot be considered soluble in water.

It results from our researches that amongst all the bases which may be met with in commercial methylaniline, *pure dimethylaniline* is the only one suitable for the manufacture of a violet dye.

Monomethylaniline and dimethylorthotuluidine give certainly fine violets of a redder tone than that of dimethylaniline, but the yield of coloring matter is but small. With monomethylorthotoluidine, on the other hand, we obtain a good yield of violet dye, but it presents the defect of being scarcely soluble in water.

Finally, the methylated derivatives of the two other toluidines yield brown and gray coloring matters of no value, and whose production ought to be carefully avoided in the reaction, which gives rise to methylaniline violet.—*Bulletin de la Soc. Chimique.*

LIQUEFACTION OF SILICIDE OF HYDROGEN.

By M. OGIER.

THE author has performed this experiment with the apparatus of Cailletet. At ordinary temperatures (about 10°) liquefaction does not take place under pressures of 200 to 300 atmospheres. On the contrary, from 50 atmospheres the cooling due to the release determines the production of a thick mist and of a manifest trickling of liquid down the sides of the tube. Under these conditions the gas is at a temperature bordering upon its critical point. It suffices, indeed, to cool it a few degrees below zero in order to effect a total condensation. Hydric silicide is liquid at —11° at the pressure of 50 atmospheres; at —5° under 70 atmospheres; at —1° under 100 atmospheres, while at 0° it remained liquid up to 200 atmospheres. The conditions of the liquefaction of this gas resemble those of marsh gas, with which it has so many analogies.

RADIATION OF INCANDESCENT PLATINUM.

By J. VIOLLE.

THE author has made a number of measurements of the intensity of the red light emitted by platinum at different temperatures, from 900° to 1775°, the melting-point of the metal. The intensity of the red light, scarcely sensible at 500°, increases at first very rapidly and then more slowly. At 2910° its intensity is not greater than at the melting-point of silver.

AMALGAMS.

By H. MOISSAN.

IF a concentrated solution of chromous chloride is shaken up in water with sodium amalgam, a part of the sodium decomposes water, gives off hydrogen, and forms soda, which precipitates a certain quantity of chrome. The other part of the amalgam produces by double decomposition chloride of sodium and an amalgam of chrome. To be certain that no sodium remains in the mercury the amalgam obtained is kept for an hour in boiling water, stirring from time to time. If this amalgam is heated in a current of hydrogen to 350° metallic chrome is left as a black amorphous slightly coherent substance. The same method serves for preparing amalgams of manganese, iron, cobalt, and nickel.

"GARNET," THE RESIDUE OF THE MANUFACTURE OF MAGENTA.

By M. JOUSSET DE BELLESME.

THIS substance dissolved in treacle is much more used for coloring wines than is pure magenta, which would give a shade too much bordering upon a rose. In a number of experiments made upon animals this color always produced fatal results. One c. c. proved fatal to a cat in twelve days. The symptoms are persistent diarrhœa and rapid wasting.

JAPANESE LACQUER.

At a meeting of the Manchester Literary and Philosophical Society, February 18, 1879, J. P. Joule, D.C.L., LL.D., F.R.S., etc., President, in the chair, a paper was read "On a Chemical Investigation of Japanese Lacquer, or Urushi," by Sadamu Ishimatsu. Communicated by Professor Roscoe, LL.D., F.R.S.

During a few months last year I had the opportunity of examining roughly into the nature of "Urushi," in the laboratory of Tokio University.

The specimen of lacquer which I had under my examination was obtained from Kuyemon Nakamuraya, in Tokio, a large lacquer merchant.

It is a milky juice of pale gray color, and gives out a certain kind of poisonous volatile gas. Some persons are terribly attacked by this poison, producing a great swelling where the acid comes in contact. During my examination in the laboratory one of the apparatus keepers was terribly attacked by this gas, producing ugly swellings all over the face. He told me at the time it was exceedingly itchy. By using the solution of chloride of sodium, carbonate of soda, acetate of lead, etc., he was said to have recovered within a week. This poison acts only on certain persons. I had to work with it for many days, yet never had any attack of the kind nor felt any uneasiness from it.

It has a sweetish characteristic smell, and has an irritating taste. It burns with very luminous flame, evolving dense black smoke like oil of turpentine.

It is to a great extent soluble in benzol, ether, absolute alcohol, etc., leaving behind a blackish gray residue in which gum was found.

Lacquer, on exposure to the atmosphere, rapidly loses its weight, and at the same time blackens on its surface; although this loss is different in different specimens, yet on the average of those which I have examined it seems to vary from 25 to 37 per cent.

When the lacquer is exposed to the action of sunlight in hermetically sealed vessels in the atmosphere, or in carbonic acid, blackening does not take place, but a large quantity of moisture collects on the sides of the vessel.

The loss of weight in the atmosphere is almost, if not entirely, due to the escape of water, with a minute quantity of carbonic acid which may be formed by the oxidation of some organic compound existing in the lacquer. The attempt has been made to estimate the relative amounts of carbonic acid and water; yet it was not successful at the time, being too difficult, and it must be left open to some future investigation.

It is by many supposed to be due to the combined action of light and air, that the blackening of lacquer in the air takes place; but this seems to be erroneous from the following experiments: First. I made a square box, which had a well fitting sliding door, and the inside of which was made perfectly black, so that practically no light is permitted to

enter. In it was placed a small quantity of lacquer at dark, and the door closely shut. On looking at it the next morning, it was observed that the lacquer had turned perfectly black, proving that it is not the light that blackens the lacquer.

Second. The bottle in which I kept my lacquer for more than three months during my examination was exposed to the incident light of the laboratory. The surface of the lacquer was turned perfectly black, forming a wall as it were; while those portions which were in contact with the sides of the bottle, which receive as much light as if there were not any glass sides before it, were not at all blackened. This phenomenon is just complementary to the first one, proving that the blackening in the atmosphere is in all probability due to the oxygen of the air, but not the light alone, nor the combined action of light and air.

The lacquer when distilled with water gives a colorless distillate which is slightly acid to test-paper, and the attempt has been made to examine the acid, but not successfully, on account of too minute quantity of the substance evolved. Distillation by itself and in a current of steam was tried also, but the results in both cases were the same as the first one. Lastly, distilled with a small quantity of dilute sulphuric acid, to aid the substance to distill over, into sugar of lead, scarcely any precipitate was obtained.

Lacquer mixes with any kind of fixed oil in all proportions; hence oil is often added as adulteration, but sometimes it is purposely added to increase its mobility.

The specimen of lacquer which I examined consisted of the following three substances:

	I.	II.
Part soluble in absolute alcohol (resin)	58·24	58·23
Gum	6·34	6·30
Residue	2·24	2·30
Moisture and other volatile matter	33·175	33·170
	100·00	100·00

As I have already mentioned, the lacquer loses its weight very rapidly when exposed to the atmosphere. For the above determination I weighed out each time samples from well stoppered bottles, and determined the weight by difference. Then this was treated with absolute alcohol, and the filtrate evaporated to small bulk and dried in an air bath at 100° C. until the weight remained constant. This is put down as the part soluble in alcohol in the above analysis. The residue was then treated with hot water, and the filtrate evaporated and dried at 100° and weighed as gum. The residue, after the gum had been removed, was then washed, and dried on weighed filter at 100° C., and weighed as residue. The moisture and other volatile matter were of course determined by the difference.

The estimation of the amount of part soluble in alcohol, after the lacquer had been exposed to the sunlight in open vessels for some twenty or thirty days, shows that the soluble part increased up to 72·82 per cent. This number, when calculated for the substance to have lost 28 per cent. moisture, and other volatile matter during exposure, then equals 58·3 per cent., which is nearly equal and practically the same as the analysis previously given; hence there seems to be no material change in the amount of matter soluble in alcohol. Now the perfectly dried lacquer, after being finely powdered, was dried at 100°, and analysis gave:

Part soluble in absolute alcohol	18·07
Gum	3·63
Residue	78·30
	100·00

Altogether, from this analysis, the residue being increased, the lacquer seems to have undergone some change; but possibly this is owing to the fact that the alcohol as well as water seem to have had less complete access to the material.

Thus the "Urushi" consists of three principal constituents: (1) a resinous part soluble in alcohol, (2) gum, and (3) residue. Although there are, in addition to these, water and volatile matter, as they go away sooner or later before it is used, they are not properly called the constituents.

(1.) Part soluble in alcohol (resin) seems to be the principal portion, and has a smell like ordinary lacquer, but it never dries as the original does. It is brownish black, and slightly sticky to the touch. When treated with potash solution it forms a bluish black precipitate, but nothing is obtained on addition of sulphuric acid to the filtrate.

When boiled with hydrochloric acid, the resin is transformed into a substance elastic while hot, something like the mass obtained when heated sulphur is dropped into cold water. When boiled with nitric acid nitrous fumes are given out, and the mass gradually becomes yellow, and finally a beautiful orange colored mass was obtained. This mass was washed with hot water several times, and then treated with absolute alcohol. The mass was to a great extent soluble in the alcohol, leaving behind a small quantity of a yellowish body (which I think to be part not sufficiently acted upon by the acid). This alcoholic extract forms a beautiful yellow precipitate with both nitrate of silver and acetate of lead. I took a quantity of alcoholic extract, precipitated it with acetate of lead, and the precipitate was thoroughly washed with absolute alcohol, and then decomposed by means of dilute sulphuric acid. (It might be better to decompose this salt with sulphureted hydrogen, but we cannot do so on account of the reducing action of this gas.) The mass was dissolved again in absolute alcohol, then separated from sulphate of lead.

Now then this separated alcoholic extract was again precipitated by sugar of lead, and, after filtering and washing, the precipitate was dried partially in an air-bath, and carried under the receiver of an air-pump and dried over sulphuric acid.

This lead salt exploded when heated. The amount of lead was estimated as oxide by igniting it with nitric acid, and the salt was subjected to organic combustion. Nitrogen was determined by Dumas' method.

The following numbers were obtained as the mean results:

Carbon	26·93
Hydrogen	4·11
NO_2	18·44
PbO	47·42
Oxygen	3·10
	100·00

Now I prepared the silver salt of the same, and obtained 18·5 per cent. of silver as the result. It seems to give no help as to the formula of this body.

As such was the case, I took alcoholic extract of the original lacquer, and precipitated it with acetate of lead, and after requisite purification and drying the precipitate was analyzed. Lead determined as before.

The following is the mean of two experiments which I was only able to try:

Carbon	50·450
Hydrogen	5·705
PbO	3·775
Oxygen	40·070
	100·000

(2.) The gum is soluble in cold as well as in warm water. It has no smell, almost no taste; it has a yellowish or rather brownish color, and is of a non-crystalline body. It is quite insoluble in alcohol.

On subjecting this substance to organic analysis I got the following percentage of hydrogen, carbon, and oxygen:

	I.	II.
Carbon	41·20	41·45
Hydrogen	6·51	6·58
Oxygen	52·29	51·97
	100·00	100·00

These analyses yield a formula approximating to the composition of common gum.

(3.) The residue is, I think, nothing more than the mixture of cellulose, bark, dust, etc.

In concluding my paper, I must say that I am not at all satisfied with my present analyses, but I thought it might be of some interest to some of you from the point that, although the varnished articles from this juice are so celebrated, yet, as far as I am aware, this is the first analysis of the kind that has been heretofore attempted, and might be of some use to those who are interested upon this subject

PHILOSOPHICAL SOCIETY OF GLASGOW.*

THE first paper was read by DR. JOHN CLARK "On the Action of Phosphureted Hydrogen on the Animal Organism." His experiments were carried out in conjunction with Dr. Henderson. Small animals, usually rats, were introduced into the jar. There appeared to be considerable difficulty in breathing, and itchiness of the skin. Death took place usually within half an hour. A very small amount of gas has a fatal action; even 1 part in 5,000 causes death. The blood was dark and venous, and the lungs inflamed. Portions of the liver and blood were tested for phosphorus compounds by introducing them into a flask in which hydrogen was being evolved from zinc and hydrochloric acid. The flame of the hydrogen had a green color, and exhibited a spectrum of green bands, characteristic of phosphorus.

MR. TATLOCK read the second paper, "On Magnetic Iron Sand from the Kyles of Bute." This sand forms black streaks on the Argyleshire shore. It is separable into two portions by the magnet, both of which have the same appearance and crystalline form; one is magnetic, and the other not. On analysis the magnetic portion was found to contain 83·55 per cent. of Fe_3O_4 and 15·6 per cent. of Fe_2O_3; and the non-magnetic portion contained 0·67 per cent. of Fe_3O_4 and 97·64 per cent. of Fe_2O_3. If the magnetic variety had been oxidized to the non-magnetic variety no disintegration of the crystal had taken place.

The last paper was read by MR. J. B. HANNAY. The subject was, "Variation in the Magnetic Constituents of Minerals." It has been observed that many rocks are feebly magnetic. The author's method of determining the amount of this magnetic attraction has been elsewhere described. It consists of suspending a sample of the rock to the beam of a balance, and determining the amount of oscillation produced by a magnet placed above the pan. The magnetic constituents of these rocks, comprising specimens of pyrochlor-obsidian, natrolite, rhodonite, and gneiss, were separated by pulverization and attraction by a magnet. The portion separated was again reduced to powder and the magnetic portion again separated, and so on till no non-magnetic residue remained. The magnetic portions all had almost the same specific gravity, and after deduction of a silicate of ferroso-ferric oxide, $Fe_3O_4.2SiO_2$, the residue was found to approach the composition of a spinel, composed of an oxide of the formula $M_2O_3.MO$. This residue was magnetic, when iron constituted either one or other of the oxides, the remaining oxide consisting of alumina or lime. Mr. Hannay's conclusion, therefore, is that such a mixed oxide, or spinel, may possess magnetic properties when associated with magnetic silicate of ferroso-ferric oxide.

LANTERN SLIDES AND TRANSPARENCIES.

By WILLIAM BROOKS.

I FIND that different samples of pyrogallic acid will give different tones. I have now in my possession three different samples: one will develop the image of a warm red tone; another gives an image of a greenish tint with good intensity; and the third sample gives a very thin, slate-colored, miserable looking thing, and no amount of alkali will alter their character. Then, again, I find also different results obtained by using different samples of carbonate of ammonia. I believe there are two sorts in the market—the ordinary commercial, and the resublimed. The former sample has the tendency to give a greenish tint to the image; and the latter generally gives a rich vigorous tone, with a reddish cast. I always find it best, when purchasing, to get this article from some large wholesale house. Several times, when I have run short, I have obtained some from the nearest chemist and druggist—and to my sorrow. I find the best way of keeping carbonate of ammonia is to keep it in a jar or wide-mouth bottle, with a well-fitting cork, and keep the bottle or jar, mouth downward, in the coolest place in the house. Liquor ammonia gives, generally, a bluish kind of image, and I very seldom use this at all.

After the plate has been exposed either by contact or in the camera, it is flooded with three parts of methylated spirit and one part water, allowed to soak well into the film for about one minute; the plate is then well washed (or, what is preferable, soaked) in a dish of clean water for two or three minutes, and then well washed under the tap, and a developer poured over, made from the following solutions:

A.—Saturated solution of carb. ammonia	4 ounces.
Bromide of potassium	2 drachms.
Water	8 ounces.
P.—Pyrogallic acid (best)	96 grains.
Absolute alcohol (805°)	1 ounce.

For a quarter plate put about two drops of solution P into a clean measure, and about two drachms of solution A, and pour over the plate at once. I prefer to develop the small plates in a little cemented glass dish, as described by me some years ago in one of the Year Books, as I can easily see through it and watch how the intensity is going on. I find, as a rule, almost every sample of emulsion will stand the developer compounded as above. Should the subject be one of violent contrasts, one drop of pyro will be found sufficient, and with a weak and flat negative five or six drops will not be found too much. The image must be developed to its full intensity—if anything, a little above—as the fixing agent used is more powerful. After the plate has been well washed, it is fixed in a solution of cyanide of potassium. Hyposulphite of soda is useless in this instance. I use it about the following strength:

Cyanide of potassium	20 grains.
Water	1 ounce.

It will be found best to use this in a dish, and immerse the plate in it, moving the dish about. It will fix in about two or three minutes. By using cyanide instead of hypo, we obtain one of the most wretched colors imaginable—of a nasty yellowish buff, and it is by obtaining this color we are able to tone to any tint we please. Care must be taken not to allow the cyanide to act after the film is well cleared, especially if the image is thin; but, at the same time, all traces of the unaltered bromide of silver must be dissolved. The plate is now washed under the tap for about a minute, and then allowed to soak for about a quarter of an hour in a dish (the larger the better) of clean water. This washing must not be shirked, or the toning will be uneven. When removed from the dish of water, it is again well washed under the tap, and is then ready for toning.

The best toning agent I find for the purpose is bichloride of platinum. I have tried chloride of iridium, and though I have not yet succeeded to my satisfaction, have not given it up.

Toning Solution.

Bichloride of platinum	2 to 4 grains.
Water	20 ounces.

The toning is best accomplished in a white dish. After the plate has been well washed, it is placed in the toning bath, and the dish must be well rocked about to insure even action. It will at once change from the miserable yellow color before described, first to an orange tint, and then to pale claret, to deep claret, to purple claret, pure photo-tone, warm black, deep black, engraving black, and finally to a slaty black, something like platinum gives with an ordinary bath plate. Now the toning can be stopped at any stage, according to taste and subject. It almost may be termed a magic system of toning. If the plate has not been washed sufficiently, it will tone in streaks and patches, which can never be overcome unless the toning is carried on to the slaty tints. After the image has been toned sufficiently, it may, perhaps, be found a little too intense to give the best result in the screen; if so, it can be passed through the cyanide again. In so doing, if only the red warm tone has been obtained, the tone instantly is destroyed on immersion in the cyanide solution, which also at the same time reduces the image to the required depth; but if the black tones have been obtained in the first instance, it has but little effect upon the color; the only effect the cyanide solution has, is to reduce the intensity or clear away fog. The warm tones are composed of silver and platinum, and the black tones of platinum only.

Now, if we compare a slide that has been toned with one that has not been toned, it will be readily seen that the toned one is far superior as regards texture and clearness. The untoned slide looks almost perfect when seen alone, but together the detail has the appearance of being clogged up. The black cold tones are very suitable for making enlarged negatives.

I must not omit to state that it is impossible to get good tones on very weak images. Better tones are obtained in transparencies that are suitable for decorative purposes, but lantern slides can be made sufficiently intense to bear any tone required. I am in hopes, in a few years, to see a greater interest evinced in this beautiful branch of our art-science than it has hitherto received.

One drawback with the system that I originated with the use of acetate of soda, etc., with the alkaline pyro, was, that it was at times difficult to get a series of transparencies of the same tone; but with this method the toning can be stopped just at the moment the desired tone is obtained, exactly the same as a silver print.

Before I close, I must also call attention to the bichloride of platinum. Samples at time will vary, and I hope I shall not transgress the limits allowed to contributors in these pages in stating—mostly for the benefit of photographers residing at a distance from large towns or cities—that bichloride of platinum can be obtained at Messrs. Hopkins & Williams, Cross Street, Hatton Garden, as I am well aware that it is not kept in stock by the ordinary photographic dealers. I am also busily engaged in working out several other branches of photography where platinum toning plays an important part, and also hope to have the pleasure of making them public.

I must not omit to mention that the toning need not be done in the dark room; it can be done in full daylight, as it has been fixed, by toning in a white porcelain dish; lifting the plate up at about the angle of 45°, the tone is readily seen. Should the solution tone too rapidly it can be diluted with water. I use ordinary tap water. After washing and drying, it can be varnished in the ordinary way. The best varnish that I find for the purpose is made as follows:

White hard spirit varnish	1 part.
Methylated spirit	3 to 6 parts,

according to the thickness of the white hard varnish. Some samples will bear more spirit for diluting than others. For lantern slides it is best to use the varnish as thin as possible; if used too thick, after a time it will crack, from the heat of the lantern. The best guide is to thin it down so that only a slight gloss is seen on the varnished film; if it is too thin, it dries dull and dead. I have seen many slides ruined by using the varnish too thick.

In conclusion, I will give a hint or two about mounting. I generally use masks black on both sides, and on one side I write the name of the subject in white. For this purpose I use moist tube water color, and thin down to the consistency of cream, using an ordinary steel pen kept for the purpose, keeping the bottle containing it well corked when out of use. By adopting this system the white letters can readily be seen in a dull light, and the side that the inscription is written on goes next to the light, unless the pictures are being shown through the screen, when it is reversed. Mr. G. W. Wilson adopts this method, and I think it is one of the best.

In regard to the binding of the slides, strips of gummed paper can be bought for the purpose. I generally find them

* Chemical Section, February 10, 1879.

much too thick for the purpose; and gum is the very worst thing that can be used, for as soon as it is dry it tumbles off. The thing that I have found to answer the purpose is common paste, and better still if the paste is made the way I described in the 1879 Year Book. The paper I find most suitable is black tissue paper. After the slide is mounted and cleaned, I take some thin shellac varnish, and varnish the paper binding all over; it is then almost indestructible for ordinary wear. It is a little more trouble, but it will be found well worth the little extra time that it takes.

PREPARATION OF SULPHATE OF INDIGO.

By M. VAN LAER.

THE following paper gives the methods at present used in France for preparing sulphate of indigo.

I will confine myself here to a review of the different preparations, remarking that the proportions of sulphuric acid employed vary much according to the views of different dyers; some use the fuming, or, as it was formerly called, the Nordhausen acid; others prefer ordinary oil of vitriol (D.O.V.), or a mixture of the two.

According to eminent chemical authorities we may obtain either sulphopurpuric or sulphindigotic acid, or a mixture of the two, according to the proportions, the temperature, and the length of time the acid is allowed to act upon the indigo.

According to Berzelius, indigo dissolves so much the more readily as the acid is more concentrated.

Fuming sulphuric acid should, therefore, dissolve indigo more readily than oil of vitriol.

When the weight of the acid employed is not five times greater than that of the indigo, and when the contact of the two bodies is not very prolonged, there is formed a body known as indigo purple, or sulphopurpuric acid.

If, on the contrary, we use 15 to 20 parts of the common acid, or eight to ten parts of the fuming acid, there is formed sulphindigotic acid.

According to Berzelius, to prepare sulphindigotic acid on a large scale, indigo is treated with eight times its weight of sulphuric acid, and the mixture is exposed for two or three days to a temperature of 122° to 140° F., when the indigo becomes dissolved, and produces sulphindigotic acid.

Sulphuric acid may be prepared by treating indigo in the cold with five parts of ordinary sulphuric acid. A liquid is thus obtained of a purple tint, which is diluted with water to precipitate, thus throwing down the sulphopurpuric acid, which is then washed with water acidulated with muriatic acid, till the washings contain no more sulphuric acid.

Sulphopurpuric acid is soluble in pure water, but insoluble in acidulated water.

To obtain sulphindigotic acid, or sulphate of indigo, Persoz gives the following formula:

1 lb. indigo, finely ground.
1 lb. fuming sulphuric acid.
1 lb. common oil of vitriol.

These ingredients are left in contact for forty-eight hours, and then heated in the water bath till a drop, when thrown into water, dissolves without leaving any precipitate; it is then let cool and diluted with water to bring it to 18° B.

M. Dumas directs 60 lbs. of sulphuric acid to be poured into a large stoneware pot, to which 10 lbs. of indigo are added in very fine powder. The whole is well stirred up together, and the pot placed in a trough of warm water to facilitate the reaction.

A solution of indigo, very commonly used among dyers, is the following:

A stoneware vessel is taken of such a size that the materials may not run over; into it are poured 4 lbs. of sulphuric acid (full strength), then 2 lbs. of fuming acid, and the whole is heated to 104° Fahr. When it has reached this temperature 1 lb. of indigo, finely ground and sifted, is added by small portions at a time; it is stirred for some time with a stoneware or glass rod, and then let settle for twenty-four hours. The solution is diluted with five to six times its weight of water, and well stirred up. Some dyers filter the solution thus obtained through felt; the paste which remains on the filter is mixed afresh with water and filtered anew, and the liquid thus obtained is added to the first. The residue on the filter is preserved, and is treated again with sulphuric acid.

(These three prescriptions, it must be remembered, yield so-called "sour extract," or, as it is called in some districts, chemic blue, or chemic. The solution thus obtained contains *all* the matters present in the indigo, the filtration merely removing imperfectly dissolved fragments of indigo; and unless refined indigo is made use of, which is expensive, the product will contain the green and brown coloring matters as well as the blue, and will constantly have an olive or greenish cast.)

Dijouval prepares his solution with 6 lbs. of sulphuric acid (full strength) and 1 lb. of indigo, well ground. When the mixture is thoroughly made, he allows it to settle for forty-eight hours, and introduces by degrees 1 lb. of good potash in fine powder, and mixes it well with the other ingredients. When the effervescence is over he adds boiling water.

Poerner announces that of all the preparations of indigo which he knows none appears to him more advantageous than that of Dijouval, which he modifies, however, as follows:

To 4 oz. of indigo in fine powder he adds 17½ oz. of D.O.V., and stirs the whole together for some time, letting them settle for twenty-four hours. He adds then 4 oz. of good potash in fine powder, and stirs the whole together, letting settle for twenty-four hours. He then adds by degrees 14 pints of water.

(These two last prescriptions give sweet extracts, as the indigo exists not in the form of free sulphindigotic acid, but as sulphindigotate of potash. Why potash is used instead of soda-ash or soda crystals we cannot say, except it be to make the mixture come more expensive. These preparations, further, having undergone no filtration at all, can be freed neither from undissolved bits nor from the green and brown colors.)

Although sulphate of indigo has been for some time little employed in blue dyeing, it is still extensively used for greens and mixed colors.

For bright shades wool may be dyed without any mordant, simply adding the solution of indigo to a hot water and stirring well. Then the wool is dyed at a temperature below a boil, say 158° to 176° Fahr. A boil greens the shade, fixing upon the wool a green compound, sulphoviridic acid. (In a well-made extract this green compound is almost entirely removed.)

This precaution is needless for mixtures, such as grays, greens, bronzes, etc.

In general dyers mordant wool by boiling in a water with 15 to 20 parts of alum, five of argol, and four of common salt.

The wool or cloth is then entered with the color and worked for the length of time needful to bring it up to shade. It is important not to add all the color at once.—*Teinturier Pratique—Chemical Review.*

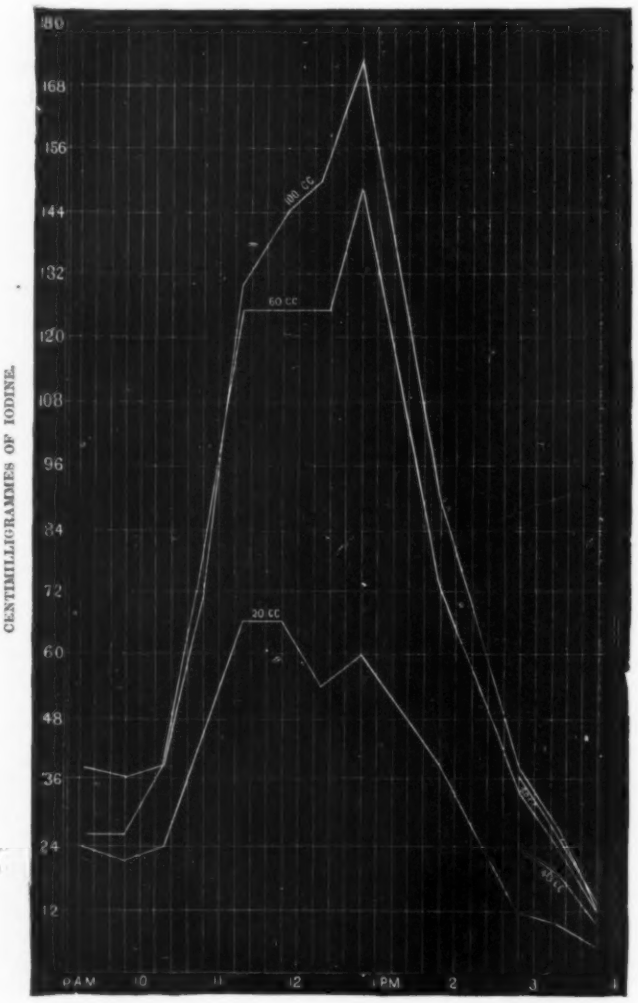
A NEW METHOD OF MEASURING THE CHEMICAL INTENSITY OF THE SOLAR RAY.

IN a recent paper, read at a meeting of the American Chemical Society, the presiding officer, Dr. Leeds, gave the results of a series of experiments upon the deportment of the metallic iodides, other than the salts of silver, and while his investigations are more especially of interest to chemists, yet they involved certain points which illustrate some of the phenomena of photography, and possibly may have a bearing upon future developments in photographic art. It is probably a fact known to many photographers, that the test for the presence of nitrites and chlorine in solution, consists in the addition of some soluble iodide, usually that of potassium, together with some starch, when if either of the above mentioned bodies is present, a blue color will be developed, the time of whose appearance and its intensity depending upon the amount of nitrous acid or free chlorine in the liquid under examination. Frequently it is of great importance to determine whether the hydrochloric acid sold by the manufacturer as chemically pure contains free chlorine, or the nitric acid C. P., contains nitrous acid. This is usually the case if the nitric acid has been for any length of time exposed to light. In the course of such an examination, 1 c.c. of the acids being diluted with 1 liter of water, and 1 c.c. of a 10 per cent. solution of potassium iodide, and 5 c.c. of starch water added. Dr. Leeds noticed that the amount of iodide of starch formed varied in different trials with the same acids, and that after the solutions had been decolorized by a standard solution of sodium hyposulphite, they again acquired a blue color on standing. In one series of experiments, this repeated liberation of iodine went on from Oct. 27 to January 3, the solutions being decolorized by the hyposulphite thirteen times during the interim. The iodide used was made with great care, and contained neither free iodine nor any alkaline iodate.

These unlooked for results gave rise to the suspicion that the light played a part heretofore unsuspected in the operation of these tests. To verify this hypothesis, parallel series of solutions, containing to 1 c.c. of potassium iodide, 1 c.c. of sulphuric acid (free from nitrous acid) and 5 c.c. of starch, 26, 60, 80, 100, 150, 250, and 500 c.c. of water were prepared, and placed one-half in total darkness and one-half in sunlight respectively. For a long time the results of these trials did not agree very perfectly, although there appeared to be in both cases a distinct law governing the amount of change. In the dark, the amount of iodide of starch formed was as the degree of concentration, the 20 c c. solution containing *most* at the expiration of 24 hours, while the 500 c.c. solution was scarcely, if at all, affected during the same interval. In the sunlight, coloration began at the end of a few minutes, and at the expiration of half an hour most or all of the starch present had been precipitated in the form of iodide. The law of decomposition appeared to follow the degree of dilution in this case, the amount of iodide set free being greatest in the solutions which were weakest. The contradictory results, however, disappeared when comparison-tubes of uniform bore, and made of the same kind of glass, were substituted for the bottles of various make, sizes, and forms at first employed. When this was done, the amount of change was rigorously proportional to the dilution, or in other words, to the volume, which again, in tubes of uniform bore, kept always at right angles to the solar ray, would be directly as the surface of exposure. Furthermore, it was found on trial, what would naturally be inferred from the foregoing, that with solutions of the same degree of dilution, the amount of change was directly proportional to the length of exposure to the sun's rays, when the intensity of the sunlight was constant, or directly as the intensity, when this experienced an increase or diminution.

Upon these laws a new method of actinometry has been founded. The usual method, originally proposed many years ago by Dr. John W. Draper of this city, and afterward elaborated by Profs. Bunsen and Roscoe, consists in determining the amounts of hydrogen and chlorine gases which are made to combine by the solar ray, or other source of illumination possessing a sufficient acting power. This beautiful method has the disadvantage of requiring complex apparatus, and of necessitating great skill in manipulation. To determine, in the method proposed, the amount of iodine set free, can be rapidly performed according to familiar modes of volumetric analysis.

To illustrate the application of this method, the results obtained for two days (Jan. 22 and 24, 1879) are given in the table below, and likewise the accompanying diagram, in which the vertical lines represent the hours of the day, and the horizontal the number of centimilligrammes of iodine



HOURS OF THE DAY

(JANUARY 22D AND 24TH, 1879.)

set free. On the first day, which was bright and clear, the actinometric determination was interrupted at 2 P. M. by the sun's clouding over, and the work could not be continued until two days later. But it will be noted that even after this interruption the curves of chemical effect in every case are parallel and continuous. In each solution, 1 c.c. of potassium iodide, 1 c.c. of sulphuric acid, and 5 c.c. of starch water were employed, diluted respectively with 20, 40, 60, 80, and 100 c.c. of water. It will be seen that the line marked 100 c.c. rises at the maximum, which was at 1 o'clock, when the amount of iodine set free amounted to over 1·7 mgrm. of iodine for every half-hour of exposure, to nearly three times the height of that marked 20 c.c. It will be noted also, that the absorbing action of the vapors in the earth's atmosphere increases as the day wears on, the lines descending much more precipitously after the point of maximum had been attained, than they had ascended before that time.

RELATIVE ACTION OF THE SUN'S RAYS. (JANUARY 22, 1879).

	20 c.c. H_2O.	60 c.c. H_2O.	100 c.c. H_2O.
9—9.30 A.M.	0·24 mgrm. I.	2·07 mgrm.	0·38 mgrm.
9.30—10	0·22	0·29	0·37
10—10.30	0·24	0·40	0·40
10.30—11	0·39	0·76	0·71
11—11.30	0·67	1·25	1·29
11.30—12	0·67	1·25	1·46
12—12.30 P.M.	0·55	1·25	1·54
12.30—1	0 60	1·50	1·73
1—1.30	0·50	1·13	1·31
1.30—2*	0·40	0·75	0·92

*Clouded over.

CONTINUED—JANUARY 24.

	20 c.c. H_2O.	40 c.c. H_2O.	60 c.c. H_2O.	80 c.c. H_2O.	100 c.c. H_2O.
2.30—3	0·125 mgrm. I.	0·24	0·33	0·38	0·40
3—3.30	0·11	0·18	0·24	0·27	0·28
3.30—4	0·07	0·10	0·12	0·13	0·12

These investigations are being continued, and Dr. Leeds hopes before long to present to the Society the results obtained with equivalent amounts of the various iodides in the presence of the same, and of different acids, and when exposed to the solar beam, the electric and magnesium light and a newly invented non-luminous actinic lamp.

TENACITY OF STARCH.

By GEORGE WHEWELL, F.I.C., F.C.S.

IN consequence of the large quantity of farina (potato starch) which is used for the sizing and stiffening of yarn and cloth, the question often arises: Given several samples of starch, which will make the stiffest cloth and which has the greatest tenacity? To my mind the best method devised so far is the one used by Shier, and is as follows: 24 grains of the sample of starch are mixed with 400 grains of distilled water, and boiled with constant stirring for three minutes, then poured into conical test-glasses and allowed to stand for two hours; at the end of which time a flat metal disk, seven-tenths of an inch in diameter, and not weighing less than 50 grains, is placed on the jelly and weights added until the skin is broken and the disk sinks.

In working the above method I find a difficulty in manipulating the weights on account of the smallness of the disk. If after a 50 or 100 grain weight has been placed on the disk you attempt to place a few smaller ones also, the pressure is exerted unevenly, and the jelly is cut by the edge of the disk and not broken uniformly. I have devised the following modification, which I have used for the last three years, and find it to answer very well. The principle is to ascertain the number of grains required of any sample of starch which, when made into a jelly, will support a 100 grain weight for five minutes without breaking the skin. I have examined a large number of samples of farina, and find the number of grains required is from 18 to 28.

To determine the tenacity of a sample of farina I take, say, six conical-shaped test glasses, 1 ounce capacity, and label the feet 18, 20, 22, 24, 26, and 28. Using a 2 ounce evaporating dish, I weigh out 18 grains of the farina, mix it with 26 c.c. of distilled water, and boil with constant stirring for three minutes. Pour it into the test glass marked 18, and shake to make the surface of the jelly level, book the time, and allow to cool for exactly two hours. At the end of this time I take a 100 grain weight (mine being thirteen-twentieths of an inch in diameter), and place it on the jelly If it is supported for more than five minutes, I place it on each of the others in succession until I come to the one through which it sinks, then I have got the tenacity to within 2 grains. The intermediate number will be found to support the weight for exactly the right time. The number of grains required I call the tenacity. If the tenacity of one sample is 18 and the other 28, it means that it requires 28 lb. of one sample to give the same stiffness as 18 lb. of the other.—*Chem. News.*

GAS ANALYSIS AND APPARATUS.

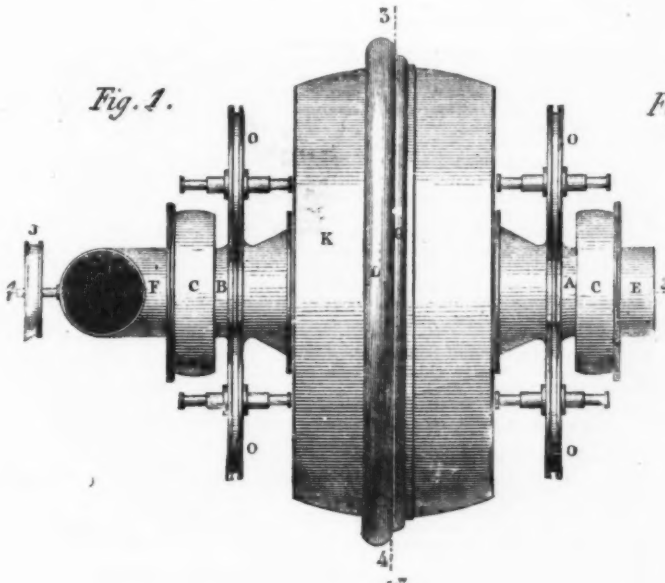
AT a recent meeting of the Chemical Society, London, a paper was read by Mr. J. W. Thomas.

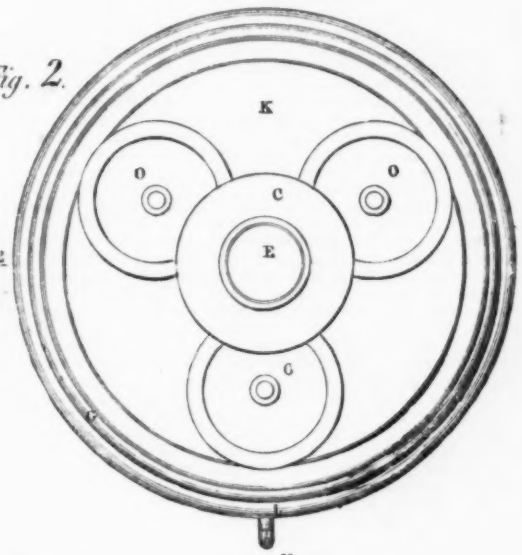
In 1874 the author noticed that when a small quantity of marsh gas was mixed with about three times its volume of oxygen and rarefied until the pressure was 160 mm. no explosion took place; similarly when mixed with twice its volume of oxygen under a pressure of 130 mm. the spark did not ignite the mixture. It soon became evident that the cooling effect of the walls of the eudiometer was the chief agent in modifying the force of the explosion. It was also noticed that the expansion of a gas to twice its volume lessened the force of the explosion to a greater extent than the addition of an equal volume of inert gas at the initial pressure. The author accordingly made estimations with marsh gas and hydrogen, using nearly the theoretical quantities of oxygen and a pressure of 160 to 170 mm., and found that perfectly accurate results were obtained, while the safety of the eudiometer tube was not in the least endangered. The author then proceeds to point out the errors which creep in when the long (800 to 900 mm.) eudiometer tube of Frankland and Ward's or McLeod's apparatus is used, and proves that the sensitiveness of the apparatus depends on the length of the pressure tube *above* the top of the eudiometer tube. With the old method of introducing a large excess of oxygen in order to moderate the violence of the explosion, this long eudiometer tube was necessary to contain the large quantity of gas introduced. On the other hand, to lengthen the pressure tube would render it unwieldy from its great length, so that with the old method of introducing a large excess of oxygen the relative lengths of the pressure and eudiometer tubes must remain unaltered; but by employing the reduced tension method proposed by the author, and in which only the theoretical quantity of oxygen required has to be introduced, the necessity for such a long eudiometer tube is obviated. The author, therefore, has shortened the eudiometer tube to about 5·0 mm., retaining the original length of the pressure tube, and finds that the apparatus has gained in delicacy and is still sufficiently large for all substances. The next modification introduced by the author is the substitution of a steel block with a three way steel tap for the glass taps connecting the barometer tube, eudiometer tube, and pressure bottle. The tubes are fixed and held tight in the steel block by India-rubber rings, screwed down by means of steel collars. Flexibility and absolute tightness are thus secured. As regards the steel tap the author has had no difficulty in keeping it perfectly tight; the three ways are gouged out on the surface of the tap and are not bored. The use of the steel plates connecting the eudiometer and laboratory tubes has been abandoned, and a hollow glass tap substituted, which is so bored that the tubes can be washed out. The mercury trough is made movable by an ingenious mechanical arrangement. The supply of water to keep the apparatus at a constant temperature is brought in at the top of the barometer tube; the exit is at the bottom, and a siphon arrangement is added to insure a thorough mixing of the water round the top of the eudiometer tube. The little windlass has been modified so that it can be worked with one hand. In conclusion, the author gives details as to the management of a gas analysis with the modified method and apparatus. A drawing of the latter accompanies the paper.

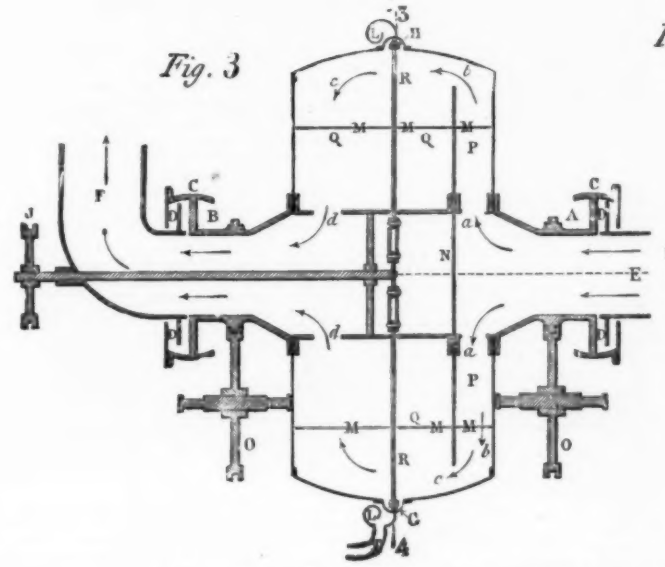
Prof. Frankland complimented the author on the ingenuity displayed and the success achieved in his paper. At the first mention of the return to the use of the steel stop cock, he must confess that he had almost shuddered. Twenty-five years ago, when glass stopcocks were a luxury, these steel taps constituted a never-ending source of annoyance. After a week's work a leak almost always occurred, which necessitated a prolonged and careful grinding. This might be due to the fact that the tap was made of cast iron and the plug was bored. The method of exploding gases with almost theoretical quantities of oxygen was a decided step in advance. The shortening of the eudiometer tube and the increased sensitiveness thereby attained, seemed to him, also, most important improvements.

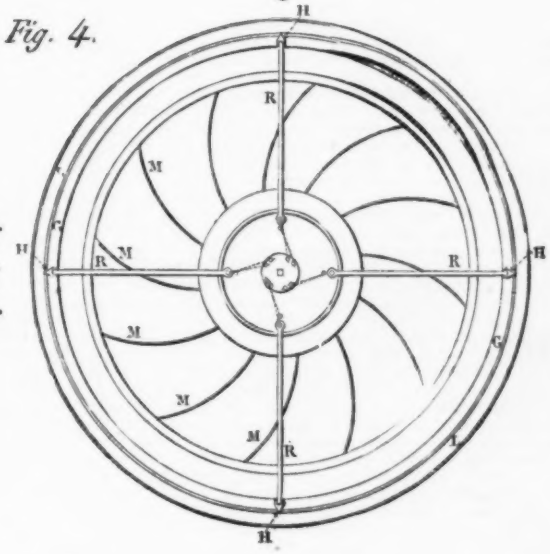
BRAUN'S CENTRIFUGAL APPARATUS FOR SEPARATING SOLID AND LIQUID PARTICLES FROM GASES.

THIS apparatus is the invention of Dr. Otto Braun, of









BRAUN'S CENTRIFUGAL APPARATUS FOR PURIFYING GASES.

Berlin, and serves to separate solid and liquid substances from gases or vapors.

In our engraving, which we copy from the *Notizblatt*, of the German Society of Brick and Tile Manufacturers, Figs. 1 and 2 are plan and side views, and Figs. 3 and 4 vertical sections through the lines 1 and 2, and 3 and 4 respectively (Fig 1).

The apparatus consists principally of the drum, K, fastened to the hollow shaft, A B, and divided in two unequal portions, P and Q, by an iron plate, N. The diameter of the drum is greatest in the middle. Here a circular groove, G, is provided, supplied with four valves, H (Figs. 3 and 4). These are generally closed, when the drum is in motion, by the action of the centrifugal force on the rods, R, but may be opened simultaneously by stopping the wheel, J. They close again as soon as the latter is released.

The shaft, A B, is supported by six friction wheels, O (Fig. 2), and receives a rotary motion of 600 revolutions per minute by means of belts passing over the pulleys C C. These are hollow, and receive the collars, D D, of the tubes E and F. The plate, N, is provided on both sides with curved paddles, similar to those of a turbine wheel. The groove, G, communicates by the valves, H, with a fixed circular channel, L. At the lowest point of the latter is provided a tube leading to a reservoir.

In working the apparatus, the drum is first started; then the hollow pulleys, C C, are filled with water, which forms an airtight joint between the shaft, A B, and the fixed tubes, E F

The apparatus described is intended to purify furnace gases. When the latter have completely been cooled before arriving at the apparatus, they can pass directly through the same; but in case the water generally contained in them has not condensed to small drops, they must be moistened by the injection of a spray of water. The vapor enters the apparatus through the tube, E, and passes through the same in the direction indicated by the arrows.

In the portion, A B, of the drum, the paddles impart to the smoke the velocity of the drum, while in the part, *c d*, they tend to diminish its speed. The gases pass out through the tube, F, while the water, the soot, the tar, and sparks gather in the groove, G. Every ten minutes the wheel, J, is stopped for a few seconds, the valves, H, being opened, the contents of the groove, G, are thrown into the channel, L, from which they are conducted through the tube, F, to a reservoir.

For gases containing solid impurities only, the apparatus must be somewhat changed, so, for instance, for the purification of the air in white-lead and zinc works.

LOSS OF HAIR.

By JOHN V. SHOEMAKER, A.M., M.D.

HAIR is merely modified epithelial tissue inclosed in follicles, and is found over almost the whole surface of the skin. It may be long, as on the scalp; short and thick, as on the eye-lashes; or soft and delicate, as over the greater part of the surface of the body. The length of the hair ranges from one line to one yard, and varies much in the two sexes and in different parts of the body. According to the accurate observations of Wilson, the thickness of the hair ranges between 1-1,500th and 1-400th of an inch, being finer in children than in adults, and coarser in women than in men. As regards color, the hair may be either black, gray, white, light brown, dark brown, red, chestnut, or flaxen. The hue will be modified according to the quantity of pigment present and the manner in which it is arranged in the fibrous part of the hair. The hair is lightest in northern climates and becomes darker as we pass southward. The hair acts as protection in both cold and warm climates. It is of service in assisting to maintain the temperature of certain parts of the body, and assists in eliminating some of the effete matters from the system. It is a means of defense for the eyes and the nostrils, and in certain occupations prevents the entrance of dust and dirt into the lungs. It likewise serves to adorn and beautify the features. Its loss, which is of frequent occurrence in young persons and in those in the middle period of life, is therefore, not only a source of great inconvenience and distress, but also of great disfigurement. This important part of the economy seldom receives proper attention from either physician or patient. Patients should be made aware of the evil resulting from neglecting the hair, and physicians should understand thoroughly how to prevent its loss; and, when such loss occurs, the proper manner of treating it and avoiding disfigurement should be known.

The hair may fall out in patches or by general thinning, and it is to this latter class of cases I shall briefly allude. The shedding of the hair by the atrophy of the tissues with the advance of age is preceded by general thinning, but as it is a natural change it should not be regarded as a disease, and will not, therefore, require any particular attention. Loss of hair, as a result of diseased action, occurs in both sexes, but most frequently in males. It may occur at any period of life, but is most common in young adults. It may concern the entire surface, or only a portion. It usually, however, involves the scalp or the beard. When the disorder involves the head, it usually begins about the vertex and extends until all the superior and anterior part of the head is bereft of hair. The hair may be shed rapidly, coming out especially during the act of combing or brushing, or it may fall out slow and progressively, and this is the course in the majority of cases. In one variety of the disease, the scalp is to all appearances healthy, no crusts or scales being present. The hairs are dull, wanting in pigment, and when compared with the healthy hairs on the side and back of the head are found to have decreased in both length and thickness. These hairs are cast off from time to time, and are replaced by finer ones, until the entire superior and anterior portions of the scalp is filled with very short and fine hairs. The disorder usually progresses for years without attracting the patient's attention until the loss is pointed out by some friend or acquaintance. If the diseased condition is not arrested the small, downy hairs will in turn be cast off until the crown of the head becomes permanently bald. In these cases the hair over the rest of the body usually goes on growing in the natural condition. The patient, during the period of the shedding of the hair, will appear to be in good health, but a careful examination into the case will reveal the evident cause of this disorder. It will be found, as has been suggested by Von Barensprung, that this variety of the disease is due to a failure in the nerve power of the part. It occurs among those who are overworked, either mentally or physically. It is most liable to result from excessive strain, especially among professional men and men of active business duties. It is observed to result from unsuitable food, debilitating diseases, anxiety, grief, fast living, heat, neuralgia, and rheumatism.

The next variety of general thinning of the hair occurs also upon the crown of the head. The scalp is covered with dry scales or crusts of various dimensions, or both may be present in the same case. Excessive cell proliferation takes place all along the course of the follicles. The small dry and white scales are loosely distributed over the different portions of the scalp. When the surface is closely examined with a magnifying glass the scales are found to plug up all the open follicles. If this scurfy material is detached the surface of the scalp will present a gray and atrophied appearance. The hair is dry, withered, and lacks luster. It is detached slowly and successively in combing, and even during the ordinary movements, until it becomes very thin or permanent baldness occurs. The crusts when present are firmly attached in the follicles, and when removed will expose a red and unhealthy condition of the part. If the scalp is not properly cleansed in either case the accumulation of discharged sebum will alter and obliterate the follicles. This abnormal condition of the part will sometimes cause itching, and the scratching thus induced may cause eczema. This secondary change may mat the hair and crusts together and quickly kill the growth of the hair.

Those who are afflicted with this variety of the disease will generally have a lowered vitality, which will be expressed in cold extremities, dry and pale skin, or in some functional derangement. Syphilitic poison may give rise to an infiltration, or ulceration around the sebaceous glands and follicles, and so result in the loss of the hair. Ringworm in children will often lead to destruction of the follicles and end in baldness of the affected part. Among other prominent causes are erysipelas, variola, lupus psoriasis, dyeing the hair, long-continued pressure on the scalp, and wearing coverings on the head that cause profuse sweating. Although the scalp is more abundantly supplied with hair in women than in men, owing to the hair being more scanty over the rest of the body and the superabundance of nutritive pabulum being carried to the head, yet the majority of women prevent the hair from growing in the proper manner. It is the incessant curling, crimping, and the injurious modes of dressing the hair that destroy its beautiful, soft, and glossy appearance, and arrest its growth. It is also the bleaching and the powdering of the hair that render it dull, plug up the follicles, and cause it to be cast off in handfuls.

If the hair received the proper attention, many cases of general thinning and premature baldness might be prevented. The use of close fitting hats and bonnets and the tension of the hair should be avoided. It should be exposed to the air every day, as this will assist in nourishing it. It should likewise be regularly cleansed by bathing with soap and water, as with the rest of the body, so as to wash off the effete material that exudes from the surface. It is impossible to restore the hair lost by the natural changes of advanced years, or when the follicles are destroyed, or cicatrized; but if the follicles with their papillæ are healthy and no atrophy of the tissues has taken place, partial or complete restoration of the hair is possible, providing the remedies are properly employed. The majority of cases will require both internal and external treatment. Each case will demand special management, according to the causes of the disorder. For instance, syphilitic taints will require specifics; rheumatic and neuralgic conditions will call for anti-rheumatic and neuralgic remedies; unsuitable nutrition will demand good, substantial food; and crimping, powdering, bleaching, and dyeing the hair will require an abandonment of the injurious habit.

With regard to those cases in which the patient is apparently in good health and is unconsciously losing the hair, tincture of ignatia, mercury, and sulphurous acid have, in my experience, been the most successful remedies. Some cases respond nicely to ten drop doses of tincture of ignatia, or one-half a drachm of sulphurous acid three times daily, with bitter tonics, while others show a more decided improvement upon very minute doses of mercury. Mercury, when given in very small doses, is a very decided tonic, and is especially valuable in the first variety of the disease as described above. The failure of the constitutional treatment to act promptly in many cases is owing to the manner of employing the medicine, and not to the use of any special remedy. For example, should mercury be given in the ordinary dose, or should it be persisted in for a long time, it will be found to pass off by the secretions, and do very little toward benefiting the patient. If, on the contrary, mercury be administered for a short period in the amount of 1-15th to 1-20th of a grain, of either the mild or corrosive chloride, and then the tincture of ignatia with a bitter tonic be substituted, and so vary the remedies from time to time, according to the patient's condition, the result will be either beneficial or successful.

The internal treatment should always be aided by appropriate external applications. In the first place, the head should be immersed in cold water every night and afterward rubbed with a rough towel, until a warm glow is produced over the surface of the scalp. The head should likewise be thoroughly brushed from time to time until redness appears; and this brushing is especially serviceable in women. Active friction to the scalp, in order to awaken the sluggish circulation, is indispensable, and the friction should be increased or diminished according to the insensibility or sensibility of the part. The short, ragged, and lusterless hairs should be cut off at the ends, or plucked out. This will strengthen the hair and add tone and vigor to the scalp. It is also decidedly the best plan, when the long, healthy, and normal hair has disappeared and the surface is covered with a fine, downy growth, to shave the scalp. This shaving should be repeated about every three or four weeks for some time, and should upon each occasion be succeeded by rubbing the skin effectually until every part is thoroughly stimulated. In addition, occasionally passing a gentle current of electricity over the head will add very much in promoting the growth of the hair. It is of equal importance in the first variety to use some mild stimulating remedy that may assist materially the preceding practice. After washing the head, I have used with success in these cases a lotion made as follows: Strong water of ammonia, one ounce and a half; spirits of rosemary and alcohol, each one ounce; tincture of capsicum, two drachms; tincture of nux vomica, one drachm; spirits of chloroform, one drachm. This lotion should be applied with a sponge to the scalp three or four times a week. It should be rubbed in effectually until a warm glow is produced, and then the head should be bathed with warm water.

In the second variety, when the head is covered with the well-known dandruff, I usually wash off the scalp with medicated soap and water every two or three days. The soap that I prefer to use in such cases has been made at my suggestion, by Mr. L. Wolff, of this city. It is composed of one and a half ounces each of oil of theobroma and olive oil; two drachms of German camomile flowers; one drachm of precipitated sulphur, and one ounce of a weak solution of caustic soda. This soap removes all the dandruff from the head and produces a gentle stimulant and astringent effect upon the follicles and glands of the scalp. It will be necessary if the thinning or the loss of the hair is due to the formation of crusts, to remove them by oil dressings or poultices. The scalp can be saturated with oil, covered with an old piece of flannel and oil silk, and in from twelve to twenty-four hours the masses will be sufficiently soft so as to be easily removed. The parts can then be washed with the medicated soap, and sponged from time to time with the lotion previously mentioned. All that remains to be done locally, after stimulation in the first case, and the removal of the crusts and scales in the second, is to further induce the growth of the hair by the use of suitable liniments or pomades. I always prefer the use of oily preparations in place of cosmetics or pomades, as the latter are very liable to become rancid and do more harm than good. I have employed with advantage, to lubricate and induce the growth of the hair, the following liniment: Tannate of glycerine, two ounces; tincture of cantharides, one drachm; tincture of nux vomica, one drachm; oil of erigeron, two drachms; olive oil, one ounce and a half; oil of rose, and oil of verbena, each five drops. This should be applied once every day until all the dull and lusterless hairs have disappeared and there is some evidence of returning nutrition in the scale and hair.—*Med. Bulletin.*

THE thermal springs of Teplitz, which are said to have been discovered 762 years B. C., suddenly stopped flowing on Feb. 13. On Nov. 1, 1755, when Lisbon was destroyed, these springs disappeared for a short time, and when they regained their activity the water was muddy and discolored.

CULTURE OF THE CALLA LILY.

THE calla should be in every collection of winter-blooming plants, both for the home and the greenhouse. I admit that the flower has no perfume, but the pure white spathe, as it stands up so grand among the bright green foliage, is beautiful to look upon, and is admired by all lovers of flowers. It is not like many other kinds of flowers, which look well for a short time and then are done blooming for the season. The flower of the calla will last for a long time if it is properly attended to.

Having had quite an experience in growing the calla, and meeting with good success, I will give my way of culture. I let my plants bloom until May in the greenhouse; then they are put under the stage, in a shady and dry place, each pot laid upon its side, and left in that position during the summer, as they will live without any water during the time they are having a rest, which I think is best after blooming all winter. But if you should want a few flowers during the summer you can leave a half-dozen plants for that purpose. Set them in a rather shady place, and give plenty of water, and you will find that the calla will bloom in summer as well as in winter. The plants are left in their position in the greenhouse until August; then they are taken out of the pots and the old earth shaken from the roots, and divided, if they are too thick, and then repotted in fresh soil. Thoroughly scrub the pots, inside and out, before repotting them. The kind of soil I use is well-rotted manure from hotbeds, and good garden soil, with some sand, to make the soil a little loose. It should be run through a sieve and well mixed together, equal parts of each. The size of pots depends altogether whether you want large flowers or small. I find the larger the pot the larger flowers I have, but if you want small callas use smaller pots. I read a short article a few days ago on the calla, which stated that if you wanted to have plenty of flowers you must have them in small pots and in poor soil. I cannot agree with the writer on the small pot and poor soil question, for, judging from what I have seen of the calla, I think they want good soil and plenty of room in the pots.

Through the winter I water my plants every day, never letting the soil get dry in the pots. They require a great deal of water, and once a week I give them manure water, which can easily be made by taking an old barrel and put in it about a bushel of cow droppings; then fill it full of water, and stir it up when you want to use. Do not be afraid that it will hurt them; I have used it too often not to know. You will find that you will have some fine flowers that will pay you for your trouble. I saw some plants last spring that were in 18-inch pots, and they had from six to ten flower stalks on each plant, so I think that shows that large pots will not hurt them. I have been told that a good way to make the calla bloom is to set the pot into hot water and steam the roots. I have never tried it, and do not think I shall. I have all the blooms I want without such treatment. The callas should be kept in a warm place and have plenty of light and sun, and if so treated they will yield plenty of bloom to cheer you and your friends through the long winter months.—*J. F. T., in Country Gentleman.*

PLANTS OF ANCIENT EGYPT.

TRIMEN'S *Journal of Botany*, for February, contains a notice of an important paper by the late Alexander Braun, of Berlin, in regard to an examination of the vegetable remains deposited in the Egyptian Museum of the latter city. One of the questions that was sought to be solved by this examination, was whether these remains, nearly five thousand years old, presented any important differences from the same species of plants as we now know them. Prof. Braun seems to have been led to make this inquiry through the remarkable discovery of Prof. Heer, of Zurich, that the flax found in the lake dwellings does not belong to the species now cultivated (*Linum usitatissimum*), but to the *Linum angustifolium*, which is not cultivated at the present time, although a native of the Mediterranean region, France, and Britain. The fact that the latter species has fruits and seeds only half the size of those of the latter, allows of the two being readily distinguished. That flax was cultivated in great quantities, and used in many ways in ancient Egypt, is well known. Mummy cloths are always of linen, and priests were compelled to wear linen garments. In the Egyptian Museum there are two combs or heckles, which have been used in the preparation of flax, and between the teeth of which the remains of threads were found, which on microscopic examination turned out to be flax. Unger found a thread of flax in a brick of the pyramid of Daschew, by which the cultivation of the plant is carried back 4,000 years before Christ. What particular species of flax was cultivated in Egypt, however, is a point not yet settled.

From Prof. Braun's examination of the ancient vegetable remains, it seems that with the exception of a few unimportant variations from the present forms of such fruits as the pomegranate, no actual difference exists between the ancient and modern forms of the same species.

ITALIAN PRECAUTIONS AGAINST THE PHYLLOXERA.

MR. THOMAS HANBURY communicates to the *Gardener's Chronicle* an amusing, although annoying, instance of Italian official zeal, which may be repeated here as a warning to tourists or botanists who purpose visiting Italy the coming summer, and who may desire to collect specimens of Italian ferns or flowering plants. A botanical friend, who paid Mr. Hanbury a visit last spring, found to his great disgust that a number of specimens which he had carefully collected and dried were, when they arrived at the custom house, taken out of their papers, pounded up to powder and burnt. The apparent object of this excessive zeal was to prevent the introduction of the phylloxera into Italy. Although the officials "strain at a gnat," they do not hesitate to "swallow a camel," for much larger packages of plants that may really be said to be open to suspicion, viz., *loads of hay*, are allowed to pass the frontier without comment or molestation. A somewhat similar instance happened with six boxes of plants, and among them the tubers of the gigantic aroid, recently discovered by Dr. Beccari, which, on their arrival at Genoa, were not allowed to be landed. Fortunately the restriction was ultimately removed, or one of the most remarkable plants introduced of late years to botanical science might have shared the fate of the specimens before mentioned. It is evidently high time that the Italian government placed a scientific officer on its custom house staff.